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ENGINEERING • CONSTRUCTION • OPERATIONS

PIPE LINE INDUSTRY

OCTOBER
1959

Publishing Company, 1959

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FLOW TRACER

Inert Argon-41 Gets Gas Flow Answers 24

VERSATILE ROUNDBALLS

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STRONGER JOINTS

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HIGHER EFFICIENCY

What to Expect in Future Gas Turbines 46

IDEAS-FOR-THE-FUTURE

"Rubberless" Tire-"Greaseless" Bearing 52

For a "Quick Look" at this issue, turn the page . .

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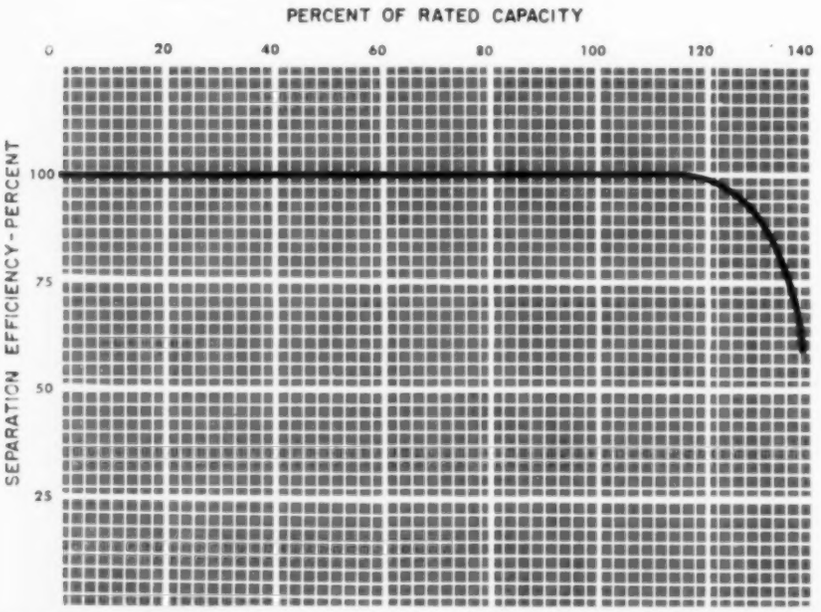
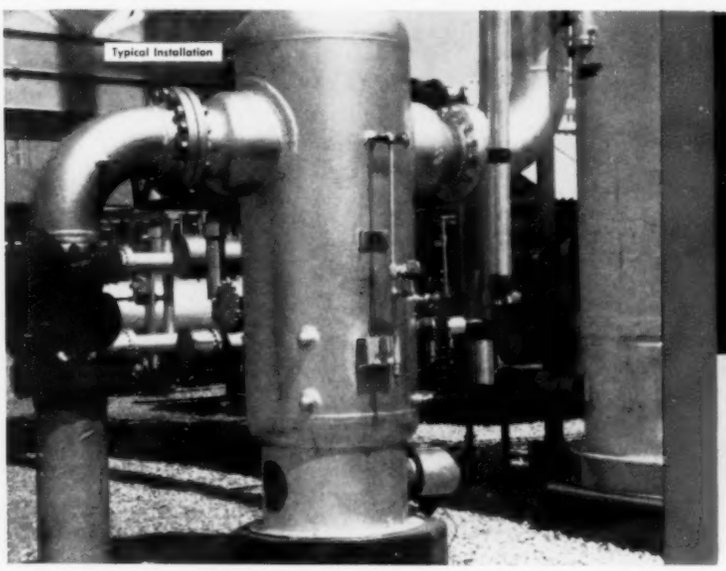
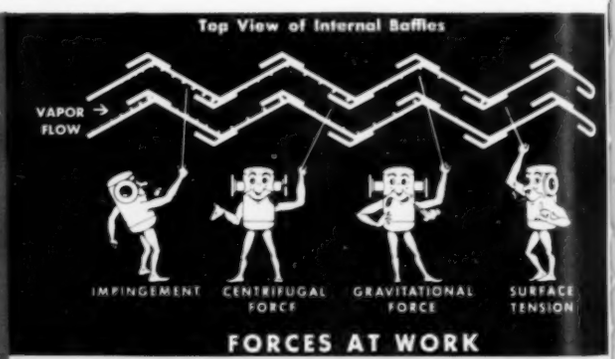
FLAT EFFICIENCY CURVE with PEERLESS Separators...



with Peerless Separators you can remove entrained liquids from process vapor lines and maintain a high efficiency over the entire range of flow.





FORCES AT WORK

The above illustration shows a top view looking down at two of the many internal separator baffles. Entrained liquid droplets are caught in the pockets and drained down out of the gas flow . . . thereby completely stripping the gas before it leaves the mist extractor.

PEERLESS MFG. CO. DALLAS TEXAS

PEERLESS MANUFACTURING COMPANY

P.O. Box 13165 Dallas, Texas

Representatives in All Principal Cities

OTHER OUTSTANDING FEATURES OF PEERLESS SEPARATORS

- Low pressure drop across mist extractor — less than 6" of water.
- Compact and economical.
- Vane units can be made easily removable.
- Mist extractor and vessel can be made of any type material. Carbon steel mist extractors can be placed in a vessel and stress relieved without damage.
- Can be designed for any capacity or special requirement.

OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE

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PIPE LINE INDUSTRY

CONTENTS and Quick Look

October 1959 Vol. 11, No. 4

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

How to Determine Gas Flow Rate with a Radioactive Tracer.

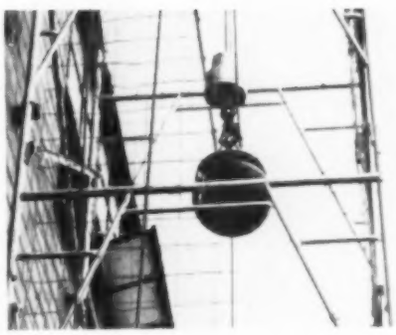
☐ There are places where ammonia cannot be used as a tracer in making pipe line gas flow studies. In addition, there are many questions still unanswered about the behavior of the blob of ammonia tracer as it traverses the line. To get some of the answers, the Pipeline Research Committee of the American Gas Association sponsored research aimed at finding a suitable radioactive tracer. A short half-life inert atom—Argon-41—is proving highly satisfactory under test. Important advances have been made in techniques for injection, tracer preparation, transportation and detection by analyzing the effect of flow distance, pipe diameter and flow rates on tracer dispersion.

By R. T. Ellington, W. R. Staats and D. V. Kniebes..... Page 24

Rubber Balls Take On New Pipe Line Jobs.

☐ Originally developed to reduce interfacial mixing in a products line, these elastomer spheroids are showing up in special applications all over both liquid and gas lines. Most interesting recent tasks have been filling and purging test sections after completion of construction, removal of liquids from offshore gas gathering systems, special cleaning runs with solvent wash slugged between two or more spheres, liquid meter proving by "automatic miles" or portable bi-directional methods and radioactive tracer flow studies. Every day imaginative pipeliners are looking at new uses.

By M. L. Barrett, Jr..... Page 31



How Does a Single-Shaft Gas Turbine Stack Up?

☐ Chances are there will be an increasing percentage of single-shaft installations in the future. The performance characteristics are satisfactory for pipe line operations and the investment is considerably less than that of dual-shaft machines. Research now centers on decreasing fuel rates and boosting the power capability of existing units. Increased operating temperatures and higher regenerative effectiveness offer good possibilities of raising power capability and efficiency. Authors cite predictions of 7,500 Btu's per hp-hour for these simple configurations of the turbine in the future. Improved regenerative heat exchangers and newly developed high temperature materials may well make this possible.

By J. O. Stephens and L. O. Tomlinson..... Page 46

Tests of Pups Support "Bridging Effect"

☐ Transition pieces or tapers simply sprang into being when high yield pipe was developed and interspersed with heavy wall low yield pipe. When this piece is made of low yield material, the thin section near the thin-wall high yield pipe should normally be the point of failure. However, the **bridging effect** gives it added strength. These findings can result in money savings on the pipe line.

By H. H. George and E. C. Rodabaugh..... Page 40

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PIPE LINE INDUSTRY published every month. Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

+

= value for your money

ORDINARILY the above two symbols would be as out of place on PIPE LINE INDUSTRY's editorial page as a side boom on top of a compressor station. But not this month.

During October more than 4,000 publisher, advertising agency and advertiser members will observe the 45th anniversary of the Audit Bureau of Circulations. This non-profit organization has become the publishing industry's most highly respected guardian of ethical standards governing audited circulation reports. Only publications with paid subscribers can belong.

Also, 43 years ago this month the first issue of *Gulf Coast Oil News* was published to mark the beginning of Gulf Publishing Company, which has become the largest specialized publisher serving the oil industry. Pardon our pride as we report that GPC's three publications, PIPE LINE INDUSTRY, WORLD OIL and PETROLEUM REFINER, have a combined circulation of more than 54,000 readers—nearly 9,000 more than any other weekly or monthly editorial effort to serve the same phases of the oil industry.

Gulf Publishing Company's success stems from three basic concepts:

1. Editorial quality builds paid circulation.

2. You, the reader, place value on what you pay for. Your decision to buy or not to buy a subscription reflects your judgment of the editorial quality of a publication.

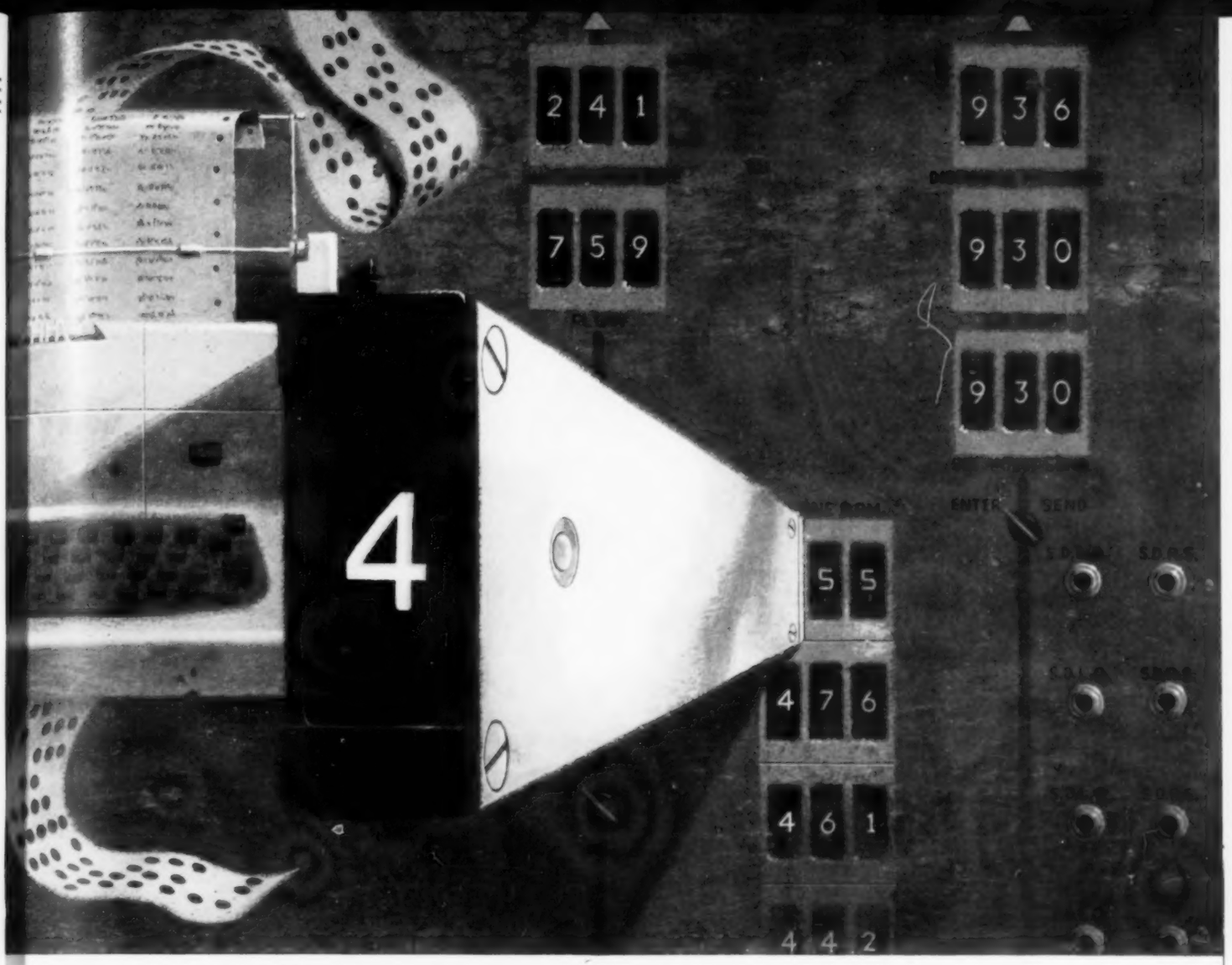
3. Advertisers get the most for their money when they buy space in a specialized, audited, paid circulation publication.

The Audit Bureau of Circulations plays an important part in each of these concepts. The Bureau sets standards for the definition and measurement of paid circulation, verifies adherence to those standards through regular audits and furnishes circulation reports to each member of the organization.

These up-to-date, audited reports help advertisers to select publications that will give them the most for their advertising dollar.

When members of the GPC staff study the semi-annual circulation reports, they find out in a hurry if they are earning their keep, i.e., providing an editorial service that will maintain a growing list of satisfied subscribers. This, plus increased advertising sales, is the ultimate reward for editorial initiative and leadership.

You see, it's as simple as adding ABC and GPC. Combine the publishing industry's symbol of circulation authenticity with the oil industry's symbol of specialized editorial quality and the result is a publication that gives you full editorial value for your money.



NEW CONTROL CONCEPT can cut your pipeline costs

Did you ever try to solve a jigsaw puzzle without first looking at the total picture the puzzle makes? Pretty difficult—maybe even impossible. Best way, easiest way is to look at the big picture first, then see where the individual pieces fit.

It's the same with pipeline control.

First, look at your total system problem. Then, determine what sort of control system is required to safely, reliably and economically meet tomorrow's need as well as today's. That is Union Switch & Signal's approach to pipeline control.

Any part of a pipeline system. Union Switch & Signal can incorporate in a centralized control system any or all of the following functions: supervisory or remote control of satellite stations . . . telemetering of flow data from field back to your central dispatching office . . . automatic sequencing or control of equipment in the field . . . instrumentation . . . data handling and display . . . computing equipment . . . automatic integration of field data into your accounting operations . . . communications. Union Centralized Transport Control can be adapted to *any* problem from remote control of a single-unit booster station for gas or oil to automatic centralized control of an entire system from wellhead to ultimate consumer.

Error-free. Whatever the job assigned to it, Union Centralized Control operates completely free from error because it reduces to coded digital form all information and instructions transmitted to or from your central control office. As a result, you can transmit far more precise data than ever before; you can use the least expensive available communications service; and you never need to worry about lightning, noise or other interference causing a wrong or dangerous operation—this coded system automatically checks itself and responds *only* to correct and logical signals. It helps make your pipeline safer. It provides error-free *security* as well as reliability.

Lower operating cost. Most important, Union Centralized Transport Control cuts your operating costs, cuts the cost of future expansion, sometimes even cuts present installation cost of pumping stations.

Write for Bulletins PD 2006, PD 2007 and 1052

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DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

CATERPILLAR'S **NO. 1** PROJECT

PAYS OFF FOR YOU AGAIN*

NEW CAT TRANSMISSION FOR THE NO.

Power shift control is mounted to the left of the operator. One selector lever eliminates gearshift, forward-reverse and flywheel clutch levers. The safety lever prevents accidental transmission engagement. The selector lever moves in a "U" path to various positions. To the left are three reverse speeds. To the right, three forward speeds. To change speed, simply move lever to the required position. To change travel direction, move lever to the opposite side. Changing speed and direction are as easy as that—without clutching—and changes can be made while the machine is in motion under full load without loss of power or momentum.

POWER SHIFT 583 PIPELAYER

- **Shifts on-the-go under full load in a split second!**
- **Changes speed, reverses direction with one finger-tip control lever!**
- **Offers precision control of the pipelayer over the roughest ground!**

The wraps are off—it's ready. After years of research and on-the-job testing, Caterpillar now offers a revolutionary new transmission option for the No. 583 Pipelayer—power shift. This new transmission—with its exclusive design—provides production highs never before possible. Here's why:

1. It combines for the *first* time the flexibility and anti-stall features of a torque converter with the operating snap of direct drive. And because of its direct drive characteristics, it's more efficient than other power shift designs.

2. With one control lever and no clutching, it reverses direction . . . changes speed . . . smoothly . . . under full load . . . in a fraction of a second.

Talk about productivity—Cat power shift delivers in a big way. Split-second, on-the-go shifts give plenty of power in the highest gear possible. Shifting is so easy the operator just naturally gets more work out of the machine. What's more, he gets it on the toughest, most demanding jobs. This new transmission means fast, easy maneuvering in such operations as leap-frogging, plus high torque in crawling up steep hills and handling big pipe. Fast, precise control of the machine lets the pipelayer inch forward in tight quarters or leap ahead to a new position down the line.

Now . . . the No. 583 Pipelayer with either torque converter drive or the CATERPILLAR POWER SHIFT TRANSMISSION. For the complete facts on the Cat power shift see your Caterpillar Dealer. He's ready to explain in detail how it works, or to demonstrate its ruggedness . . . its ease of operation . . . its productivity. Name the date . . . he'll demonstrate.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

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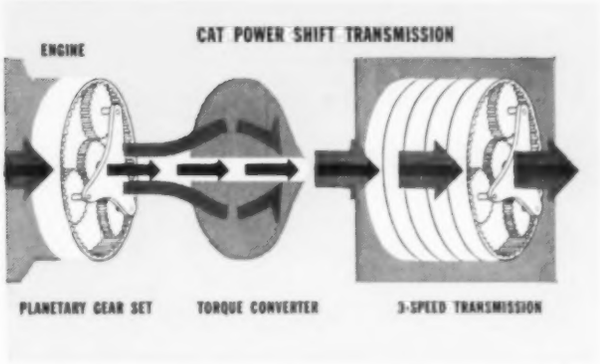
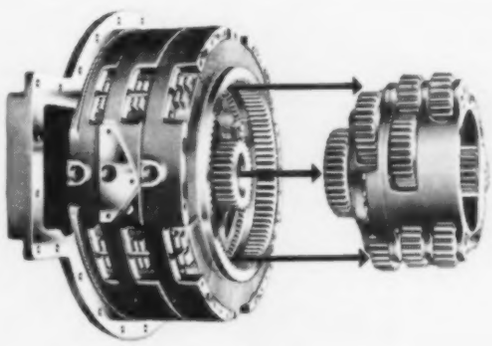
BORN OF RESEARCH
PROVED IN THE FIELD



Basic design: Total power is transmitted from the engine to a planetary gear arrangement mounted in the engine flywheel. The planetary divides and directs the total power—part goes through a direct drive shaft straight to the transmission, the remainder through a torque converter to the transmission. This enables the Cat power shift to combine the fast response of direct drive with the features of torque converter drive. Its clean, unit construction design makes it easy to service, if required.

Look at these additional features on the No. 583 Pipelayer that pay off in top production . . . **235 hp • 137,000-lb. lift • 21-inch ground clearance • Lifetime lubricated rollers • Console controls • Live power winches • Double-acting counterweight**



One ton of ruggedness: Here's a portion of the components that make up the new Cat power shift transmission. It weighs over a ton. Every component is designed and constructed for long-lived service. Selected alloy steel insures performance that stands up under the toughest conditions. Equally important, Cat power shift comes to you thoroughly tested by demanding field work in the heaviest duty. You can be sure that it will stay on the job.

***CATERPILLAR'S NO. 1 PROJECT:** A multimillion-dollar research program—to meet the continuing challenge of the greatest construction era in history with the most productive machines ever developed.

Schramm pipeline testing service in action at Renovo, Pa. Our engineer, with compressors and booster units, can roll into any terrain, get the job done fast and dependably.

NOW, SLASH PIPELINE COSTS WITH NEW SCHRAMM SERVICE:

Test pipelines with compressed air

Close-up view of boosters shows part of manifold and air line leading into the pipe being tested.

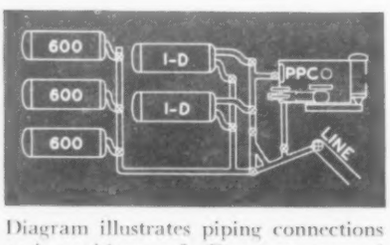


Diagram illustrates piping connections and positions of Compressors and Boosters.

Now pipeline testing is easier, "cleaner", cheaper—with Schramm pneumatic testing service. At Renovo, Pa., for example, Schramm equipment tested approximately 36 miles of a 24″ line to a pressure of 1380 psi, *operating 648 hours without stopping!* Compressed air gives constant pressure over the entire line (including grades), with a constant test figure. There is no problem of supplying or disposing of water, and lines are clean and ready to flow the minute testing is completed.

Rent or buy what you need

Schramm can rent or sell you everything you need: three Schramm 600 cfm Portable Compressors, two 1-D Boosters and one PPC Booster make up the package seen above. Package goes anywhere, operates to 1500 psi.

Schramm Pipeline Testing Service is complete—right down to the engineer who supervises the job from start to finish. We deliver to your test site, or you can furnish your own transport.

Schramm pneumatic pipeline testing is a proved success. Already paying off for contractors across the country. Write today for your own estimating chart.

See the Yellow Pages for local Sales, Service and Rentals of Schramm Air Compressors.

Schramm, Inc.

MANUFACTURERS OF AIR COMPRESSORS

740 North Garfield Ave. • West Chester, Pa.

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WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing industry

PETROLEUM REFINER and THE REFINERY CATALOG for the oil, gas and petrochemical processing industry.

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Indexed by Engineering Index

Many new techniques and methods of telemetering are available today as a result of rapid advances in the science of data processing and transmission. Today, more than ever, selection of the telemetering system best suited to a particular application requires careful study of many alternatives to insure maximum effectiveness at minimum cost.

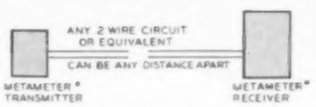
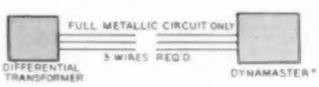
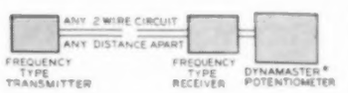
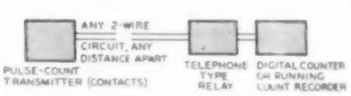
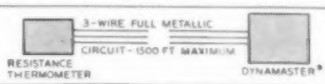
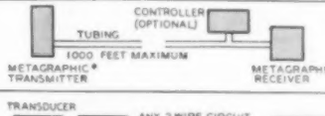
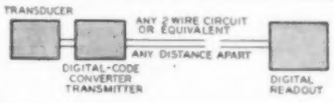
The Bristol Company offers *all* the major types of industrial telemetering systems, as outlined in the table herewith. For some applications, of course, certain features of one system may be combined with another, allowing great flexibility in tailoring a system to your application.

The complete line of Bristol industrial telemetering instruments embodies over 45 years' experience in this field. Bristol engineers are always ready to recommend telemetering instruments to solve your particular problems or to work closely with your own engineers in the design of a complete telemetering system to your requirements.

For further information, write: The Bristol Company, 114 Bristol Road, Waterbury 20, Connecticut.

TIPS ON INDUSTRIAL TELEMETERING

for pipe lines, utilities, and process industries

TYPE	OFFERED BY BRISTOL	SIMPLIFIED BLOCK DIAGRAM	ADVANTAGES AND LIMITATIONS	MAJOR USES
IMPULSE DURATION	Metameter*		Simple electro-mechanical device. Will transmit over wire circuit, carrier or microwave links. Offered in 60, 15, 5 or 2 second impulse cycles.	For analog transmission of all measurands.
VOLTAGE	Thermoverters* & Dynamaster.* D-C Transmission		Instantaneous transmission. Limited to full metallic circuits of 2000 ohms (2 wires) free of parisitic currents.	For analog transmission of electrical quantities.
	Differential Transformer Transmitter & Dynamaster. A-C Transmission		Instantaneous transmission. Limited to full metallic circuits. (3 wire.) Can operate into electronic control directly.	For analog transmission of mechanical measurands.
FREQUENCY	Frequency Type Transmitter & Receiver with or without Audio Tone. (RFL) Model with Dynamaster End Device		Practically continuous. For millivolt inputs or measurand to millivolt pick-ups. Will operate over wire circuits, carrier or microwave radio links.	Primarily for transmission of electrical measurands but may be adapted to non-electrical quantities where high speed transmission desired.
PULSE COUNT	Transmitter — Contact Making Device. Receiver — Relay Operated Magnetic Counter or Running Count Recorder		Simple. Will transmit over wire circuit, carrier or microwave link.	Primarily for total flow transmission. Not used for instantaneous flow.
POSITION	Dynamaster Resistance Thermometer System		Instantaneous Transmission. Requires 3 wire metallic circuit not exceeding 1500 feet.	Temperature measurements.
PNEUMATIC	Metagraphic System. Metavane* System		Limited to 1000 feet of ⅛" tubing. Can operate into pneumatic control directly.	For non-electrical quantities where pneumatic transmission desired.
DIGITAL	Bristol Servo Transducer with Westinghouse, G. E., or Union Switch & Signal Pulse Code System		For transmission over wire circuits, carrier or microwave.	For digital transmission of all measurands, especially where pulse code supervisory control is available. Direct print-out of readings.

*T.M. Reg. U.S. Pat. Off.

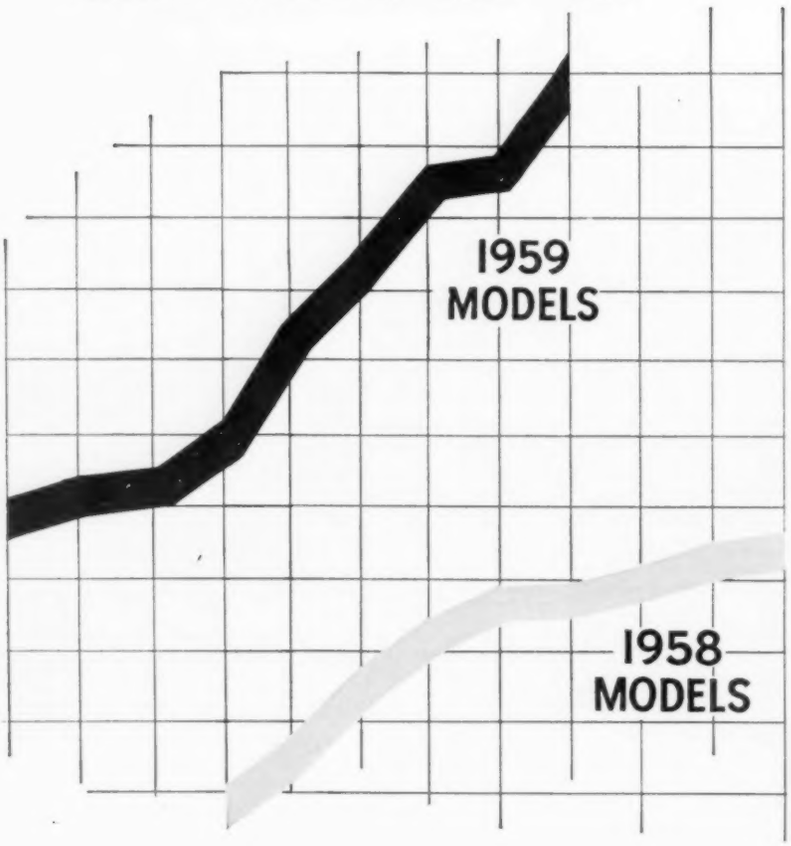
Write for technical information

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

The BIG SUCCESS

1959 FORD SUPER DUTY TRUCK SALES MORE THAN DOUBLE THOSE OF LAST YEAR



1960 FORD SUPER DUTIES

SKYROCKETING SALES OFFER ADDED TESTIMONY TO THE TOUGHNESS AND RELIABILITY OF FORD "BIG V'S"— *NOW* THEY'RE MORE DURABLE, MORE FLEXIBLE THAN EVER!

Ford's increase in sales of Super Duty Trucks, while impressive in itself, by no means tells the whole story. Over half of the 1959 unit sales were the result of repeat orders from operators like Trucking Contractors, Inc., who bought because the Ford "Big V" provided the kind of performance and durability needed for their work.

And for 1960, the Ford Super Duties offer additional refinements designed to provide an even greater degree of dependability. Bigger optional axles and increased GVW's permit greater payloads and more profitable operation. Automatic radiator shutters to keep the engine temperatures within the most efficient operating range, submerged-type electric fuel pump to prevent vapor lock, and redesigned wiring for longer, more dependable operation are but a few of the improvements which add to the performance and durability of these units.

The changes offered for 1960 were tested and evaluated by America's foremost independent automotive research organization. The certified results of the studies by this impartial firm (name available on request) provide proof that Ford's Super Duty Trucks are even more dependable.

- **Certified Durability through closer temperature control!** Independent research engineers certify that Ford's thermostatically controlled radiator shutters kept water temperature between 168° and 188° in severe mountain grade operation. The test truck with shutters blocked open

of the Big Truck Field

"Tried 8 in '58—bought 20 more in 1959," says Curtis E. Brost, President, Trucking Contractors, Inc. "In 1958 we bought 8 Ford T-850's with lightweight chassis options and specially built 5-batch bodies which gave us a full extra batch per truck. A 5-batch load is a real strain on the truck when you consider we're 'running the ditches' on this highway paving job in North Dakota. These T-850's worked out so well that we ordered 20 more in '59. Our Ford Tandems with the 477 engine give us good mileage and the drivers are real happy with them. It's a rough go on trucks with soft footing and dust so bad we have to drive with headlights on. Despite such operating conditions, downtime has been negligible and these '477' Fords have given us less trouble than other trucks we have operated."

with Certified Durability

under same operating conditions had a temperature range from 102° to 181°. The temperature variation of only 20° with shutters means less expansion and contraction in engine block and cylinder heads. Higher temperatures with radiator shutters permit leaner fuel-air mixtures with less possibility of raw gas washing down cylinder walls. Warm oil circulates more freely, reducing internal friction. All these factors contribute to longer engine life.

- **Certified Dependability with longer-lived electrical system!** Ford's '60 improved wiring harness and the 1959 wiring harness were subjected to shaker table tests plus constant exposure to oil and water vapors and temperatures of 200°. Certified results prove that the greater resistance to deterioration by heat, oil, water and abrasion obtained with the 1960 wiring harness more than doubles wiring harness life.

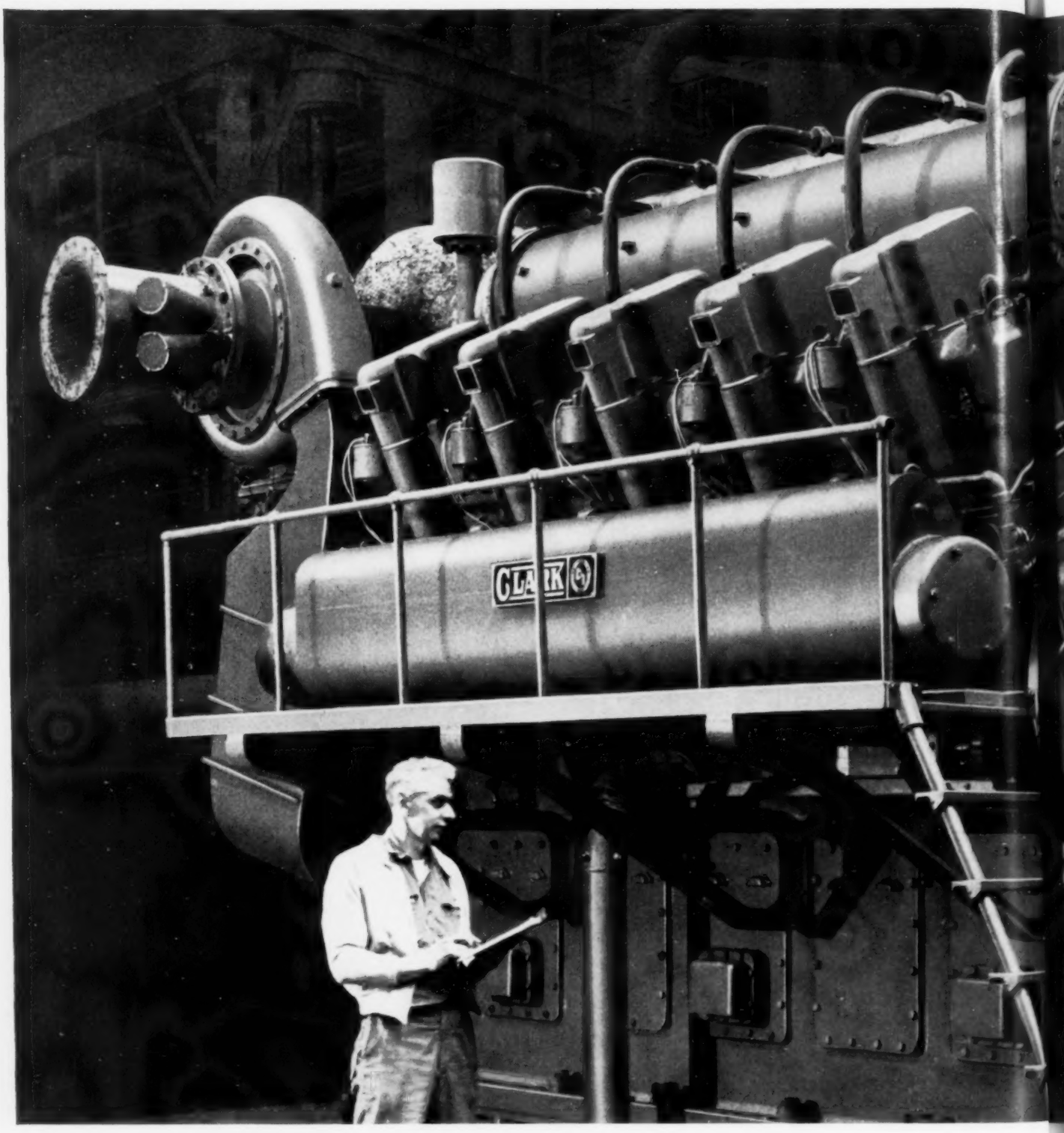
- **Certified Reliability with Ford's submerged-type electric fuel pump!** Dynamometer tests of engines with submerged-type electric fuel pump and conventional mechanical type showed that vapor lock was non-existent with Ford's electric pumps at temperatures up to 200°, whereas incipient vapor lock with mechanical pump resulted in a power loss of 9% at an underhood temperature of 200°.

Test results like these plus the experience of satisfied users are important but that is not all. For 1960, the Super Duty line has been broadened to provide even more flexibility in power train options. Get the facts from your Ford Dealer!

FORD TRUCKS COST LESS

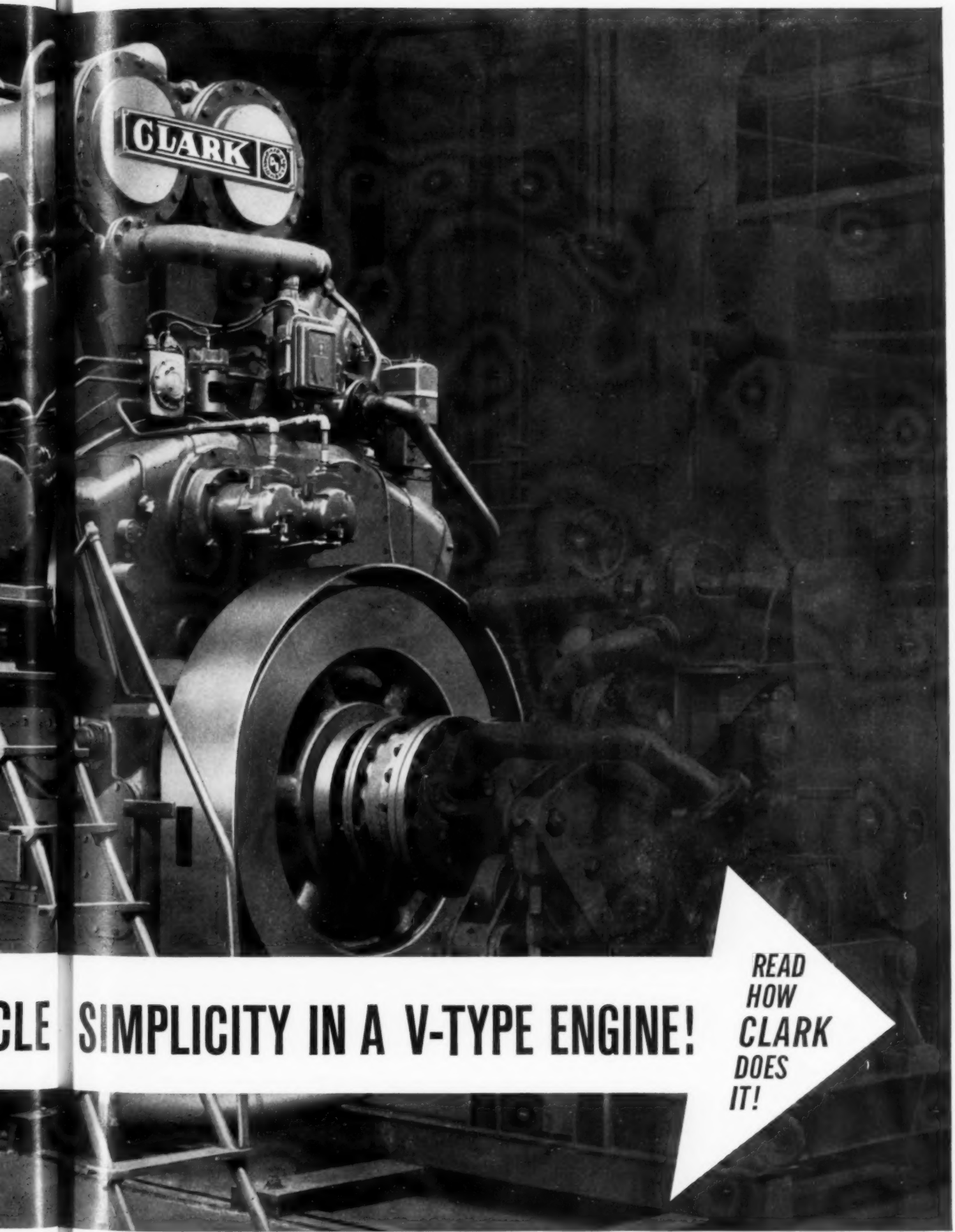
LESS TO OWN . . . LESS TO RUN . . . BUILT TO LAST LONGER, TOO!

For more data on advertised products, use Readers' Service Cards, last page.

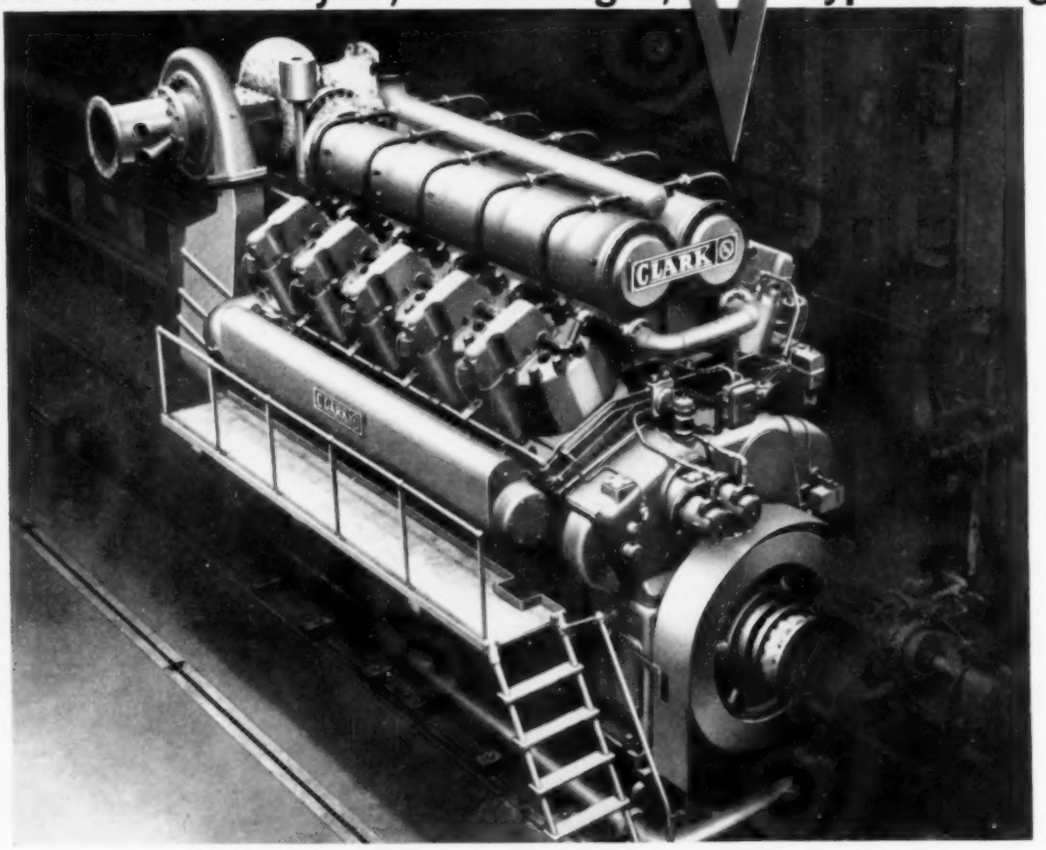


FOR PIPELINE BOOSTER STATIONS...

2-CYCLE DEPENDABILITY, 2-CYCLE


CLARK
CLE SIMPLICITY IN A V-TYPE ENGINE!
READ HOW CLARK DOES IT!

Clark Presents the TPV... 2-Cycle, Turbocharged, V-Type Gas Engine



MORE POWER
GREATER DEPENDABILITY

This is the TPV – the Clark answer to the challenging need for greater dependability and availability in pipeline engines.

Several years in development, the turbocharged, 2-cycle TPV gas engine packs huge amounts of horsepower into a compact, rugged, V-design. Even more important, it features the same dependability, simplicity and low maintenance inherent in all Clark 2-cycle machines.

Many major features and components have already been thoroughly field proved in the Clark TLA gas-engine-driven compressor. For example, the TPV has the same bore and stroke, the same basic turbocharger, a similar low BMEP rating. Compared to other engines with high operating stress, the TPV has unusual reserve capacity to handle the emergency peak demands encountered on gas transmission pipelines. At normal loads, the low stress factor eliminates excessive maintenance.

You'll save in every way – initial cost, installation, housing and operating expense. For conclusive proof, check these exclusive benefits to you:

UP TO 40% LESS PARTS – Clark 2-Cycle simplicity and reliability cuts replacements to a minimum.

UP TO 33% LOWER BMEP – Rugged Clark construction plus low operating stress (110 BMEP) mean far longer life plus unusual reserve capacity.

APPROXIMATELY 40% THERMAL EFFICIENCY

WIDE, SAFE SPEED RANGE – No dangerous harmonics in the 250-360 rpm range. Permits wide loading flexibility.

MAINTENANCE DRASTICALLY REDUCED – Lower frame loading, lower piston speeds, fewer plug changes, less lube oil contamination, no large intake or exhaust valves.

The Clark 17" x 19" TPV is built in three sizes – 10, 12 and 16 power cylinders with ratings of 4000, 4800 and 6400 bhp.

NOW GET THE WHOLE STORY. Consult your nearest Clark Office or write to Clark Bros. Co., Olean, N. Y.

The TPV-10 illustrated above shows a Clark 4000 bhp turbocharged TPV-10 under test at the Clark factory. This unit will soon be installed on a major gas transmission pipeline and will drive a Clark 24 x 24 Centrifugal Pipeline Compressor.

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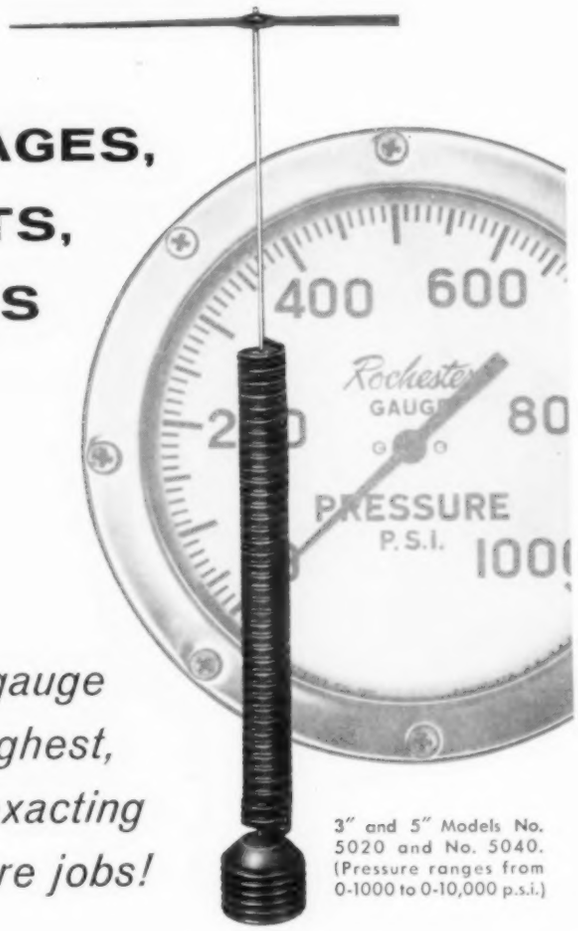
ENGINES • COMPRESSORS • GAS TURBINES

Revolutionary New ROCHESTER HIGH PRESSURE GAUGE has pointer connected directly to pressure element

NO LINKAGES,
NO PIVOTS,
NO GEARS
to wear,
waver
or lag



3" and 5" Models No. 5020 and No. 5040. (Pressure ranges from 0-1000 to 0-10,000 p.s.i.)

This is the gauge for your toughest, your most exacting high pressure jobs!

Now you can practically eliminate maintenance, replacement, and gauge failures—even under the most severe of high pressure service conditions. The new RMC Gauge, models 5020 and 5040, actually approaches the reliability and dependability of the fittings and valves used in pressure equipment.

It is the first pressure gauge to have the pointer directly connected to the pressure element, without linkage or pivots, and with no gears or hair springs.

The pressure element is a multiple turn bourdon coil, to which the pointer is permanently attached at one end. As pressure increases, the end of the coil rotates, moving the pointer with it.

The bourdon coil is made from small diameter tubing. Therefore, the pressure forces against the coil are reduced; the mechanical stress on the coil is less; and spring life, cycling life, overpressure, and endurance are all vastly higher than the conventional "C" type bourdon tube gauge.

For safety, long cycling life and continued accuracy under extreme conditions of overload pressures, high vibration, shock and line pulsation, the new RMC High Pressure Gauge is the one complete answer. Available in pressure ranges from 0-1000 to 0-10,000 p.s.i.; dial diameters 1½", 2", 3" and 5". (1½" and 2" models are eccentric pivot-drive types.)

Write, wire or phone for complete information.

ROCHESTER MANUFACTURING CO., INC.
207 Rockwood Street, Rochester 10, N. Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES

New RMC Gauge Most Sensitive to Pipe Line Pressure Changes

You know the value and importance of high pressure gauges if you have ever stood in front of the gauges at a receiving station while waiting for a change in cut. All of a sudden the needle jumps and you know that the new product has come over the hump and is on the way in.

Here's a graphic example of what a responsive pressure gauge can tell you. Whether it's a change in cut, leakage, pump failure, temperature rise, or control of a stripping delivery, pressures tell you the line story.

RMC High Pressure Gauges are particularly suited to applications where maximum sensitivity to pressure changes without lag is important, where continued accuracy, rugged dependability, and resistance to vibration is essential.

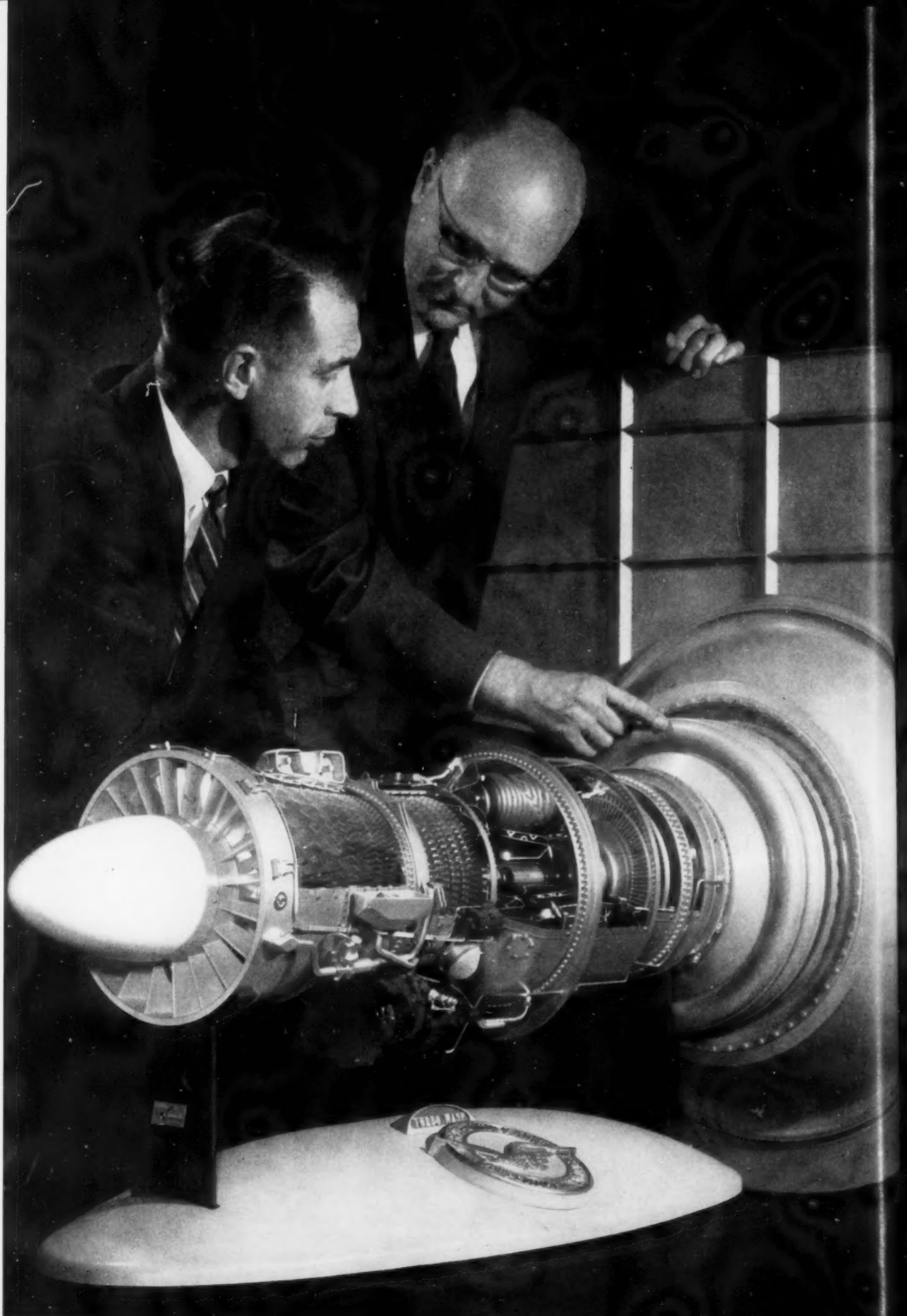
Instead of the usual C tube which must be linked to the pointer by mechanical means, the RMC gauge uses a multiple turn helical tube or hollow spring. An increase in presure which tends to straighten the "C" tube, will cause the helical coil to turn. Because the pressure-induced distortion is distributed over a much greater length, it becomes obvious that any possibility of permanent change, even due to overpressure, is virtually eliminated.

It also becomes obvious that the pointer can be directly connected—and welded—to the end of the coil, providing an accurate indication of any pressure change without resorting to linkage, pivots, hair springs or any of the trouble-causing elements. The pointer can be rotated for a full 290°.

Having no linkage to wear and cause needle flutter, the RMC gauge is particularly resistant to vibration.

Because a small diameter tube may be used, it will also be seen that the RMC gauge will be more sensitive to slight changes in pressure.

Write, wire or phone any Rochester Manufacturing Company representative . . . or write the company directly for full particulars. Rochester Manufacturing Co., 207 Rockwood St., Rochester 10, N. Y.



Quarter-scale model of experimental gas turbine being developed by Cooper-Bessemer and Pratt & Whitney Aircraft. Units should be available for use within 18 months.

How Cooper-Bessemer is teaming up with Pratt & Whitney Aircraft to develop JET TURBINE POWER for industry

The cutaway model shown is a revolutionary new concept in gas turbines. The generating unit is a new Pratt & Whitney Aircraft jet engine—a modification of the famous J-57 aircraft engine, designed for gas fuel. The companion power unit is a new Cooper-Bessemer power turbine. This combination, now in the advanced experimental stages, represents the hottest development in industrial power in 20 years. It will mean drastic economies in installations of engine-driven compressors, generators and other rotating machinery.

For example, in gas compressor stations, it is expected to reduce total station cost by 50%!

Plans call for this new gas turbine to be available for broad application within 18 months. In the meantime, watch for reports on further developments in this pioneering teamwork by Cooper-Bessemer and Pratt & Whitney Aircraft.

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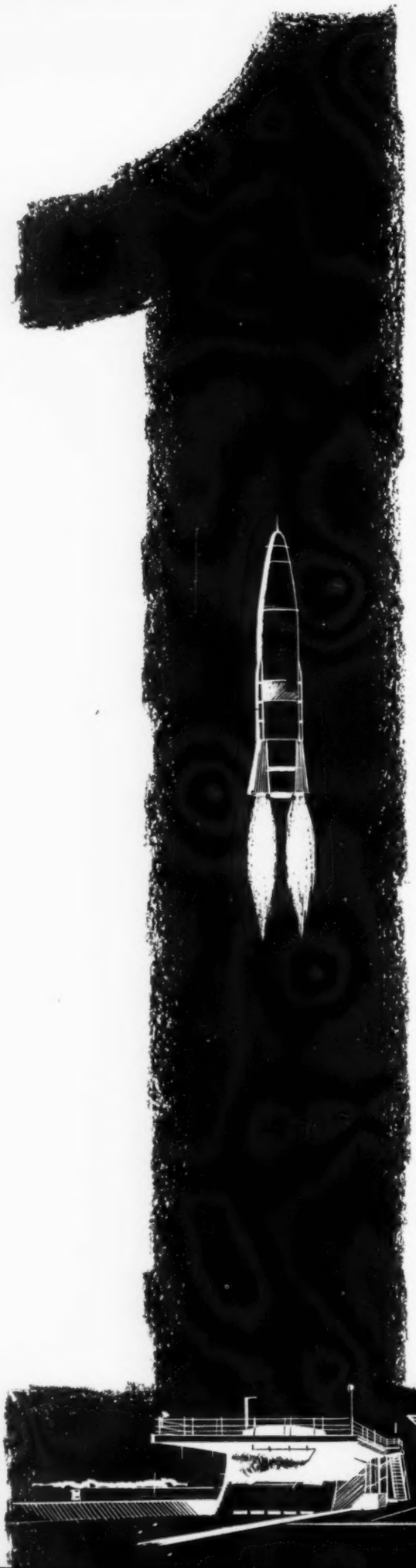

1ST

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When you have a power problem . . . and want it solved quickly . . . why not draw *first* on the tried and proved experience of Stewart & Stevenson Services . . . the world's largest distributor of diesel engines.

In our Nation's rockets and missile programs . . . as well as in thousands of commercial applications for the petroleum, industrial and construction industries . . . Stewart & Stevenson experience and "know-how" is paying off in dependable day-in-and-day-out performance. Call, wire or write today.

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THE WORLD'S LARGEST DISTRIBUTOR OF DIESEL ENGINES

Tuffy® Tips —on safe use of Slings and Hoist Lines

Safety in Hoisting Saves Costly Injuries

During a recent 12-months' period lost-time back injuries reported in one state (California) totaled 32,643. Lost-time injuries caused by strain or over-exertion: 24,639. A high price to pay—in misery and money—for lifting, pushing or carrying loads. Medical aid and compensation costs of materials handling accidents run far into the millions every year. Proper hoisting equipment, properly used and maintained, is one important answer to this problem. It may save your workers disabling injury, and save you expensive absenteeism and lost production.

Kinks Are No Hazard with Tuffy Slings

One of the first rules of safety: never use a *wire rope* sling that has been kinked. Not so with Tuffy Slings. Tuffy's patented, 9-part machine-braided fabric is just about impossible to kink. And if it should, it's easy to straighten out the kink, leaving no material damage.

Unique Ferrule Gives the Eye Splice Full Fabric Strength

The steel ferrule is slipped over the tuck-splice of the sling eye and pressed on under tremendous pressure. It gives the eye splice 100% of fabric strength. No abrupt edges or rough projections to injure hands and slow down work. And there's no extra cost for this extra efficiency and safety feature!

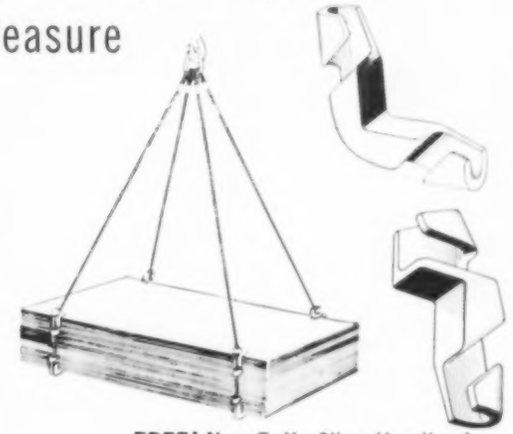
Rules for Safe Use of Hoists

1. **DON'T LET MUSCLES** do what a proper size hoist should do.
2. **SMALL HOISTS** aren't expensive. With proper slings and hoist lines, they will help greatly in reducing injuries to workers.
3. **USE THE RIGHT SLING AND HOIST LINE** for the job. Tuffy Slings and Hoist lines are "tailored" to every need, from the smallest block and tackle to giant cranes and other equipment.
4. **DON'T ASSUME** that all slings are right for all kinds of lifting. Your Tuffy distributor will help you select the right ones.

Proper Fittings Are An Important Safety Measure

Fittings used on Tuffy Slings are designed for a broad and varied range of needs. Your Tuffy distributor, or Union Wire Rope engineers, will be glad to advise you on the correct fittings for greatest service and safety for any wire rope rigging.

Shown here are Newco Sling Saddles, fittings that are widely used to protect loads and lengthen the life of slings. These saddles are made in two types: Type B and Type T. Both are shown in the illustration. Type T is used at the top of the load; type B at the bottom. They can be changed quickly from one sling to another. They eliminate the strand cutting that occurs around 90° edges and protect the load. Full data on dimensions and weights for Newco Sling Saddles—and the full line of sling fittings—are included in the Tuffy Sling Handbook that's yours for the asking (see below).



FREE! New Tuffy Sling Handbook

Revised, enlarged edition. Covers slings and sling fittings from A to Z. Gives types, dimensions, weights and rated loads. Send for your copy now. Address **Union Wire Rope Corporation, 2278 Manchester Ave., Kansas City, Mo.** Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand.

Use Tuffy Hoist Line for Greatest Economy and Safety

Tuffy Hoist Line and Tuffy Slings are the ideal team for efficient hoisting at lowest cost per ton-mile. The extra strength, toughness and service life we build into the Tuffys cost you nothing extra.

Your Tuffy Distributor Offers the Most in Service and Savings

UNION Wire Rope

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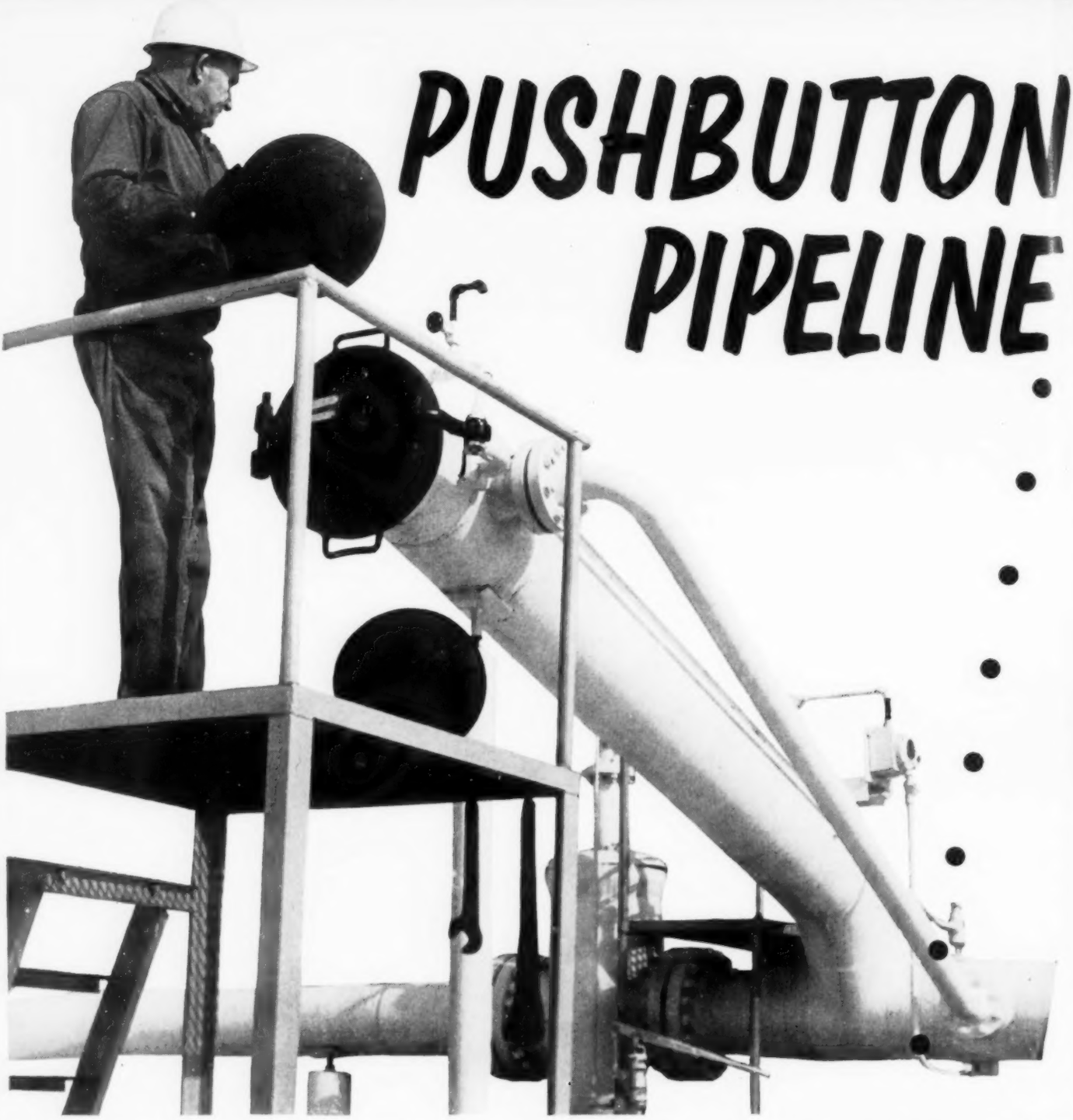
PUSHBUTTON PIPELINE



- This "magazine loading" launching barrel contains up to ten Pipe Line Spheres. After initial loading, a Sphere is launched with a push of a button. One or more succeeding Spheres can then be similarly launched at precise intervals as close as six seconds.
- Suitable for Products, Crude, and Natural Gas Pipe Lines, these automatic Sphere handling devices bring the mechanical phase of Pipe Line automation even closer to true "unattended operation." Other associated equipment includes automatic Station Sphere Bypass and Receiving barrels. It is now possible to conduct squeegee operations with Pipe Line Spheres throughout the length of a Pipe Line — fully automatically.
- Applications for automatic Pipe Line Sphere equipment include:
  Crude and Products Pipe Lines — Tender separation; with accurately bracketed interface and consequent reduction in comingling. Positive displacement meter calibration in loops or on-stream.
  Natural Gas Pipe Lines — Liquid removal. Practical two phase operation for complete recovery of distillates with full Pipe Line efficiency.
- Maloney Engineers are prepared to furnish engineering and components for application. Write for further information.

F. H. Maloney COMPANY

Post Office Box 1777 • Houston 1, Texas

Features of Maloney Pipe Line Spheres and Automatic Equipment Described Herein are Subjects of Patents Pending.

Clean PIPELINES
Reclaim TANK BOTTOMS
with BrakeSol®
an exclusive
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BRAKESOL holds paraffin in suspension! Inject it into gathering lines and BRAKESOL keeps them free of paraffin.

BRAKESOL reclaims tank bottoms without taking tanks out of service! BRAKESOL chemically dissolves paraffin and puts it back in solution into the oil. Cost is nominal compared to savings.

BRAKESOL is safe to handle and will not harm your equipment. Let BRAKESOL eliminate your paraffin problems NOW!

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PIPELINES
are in the NEWS

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So SIMPLE We Can Adapt It to ANY LIQUID LEVEL CONTROL JOB

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

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Please send me catalog data and full information on Magnetrol Liquid Level Controls.

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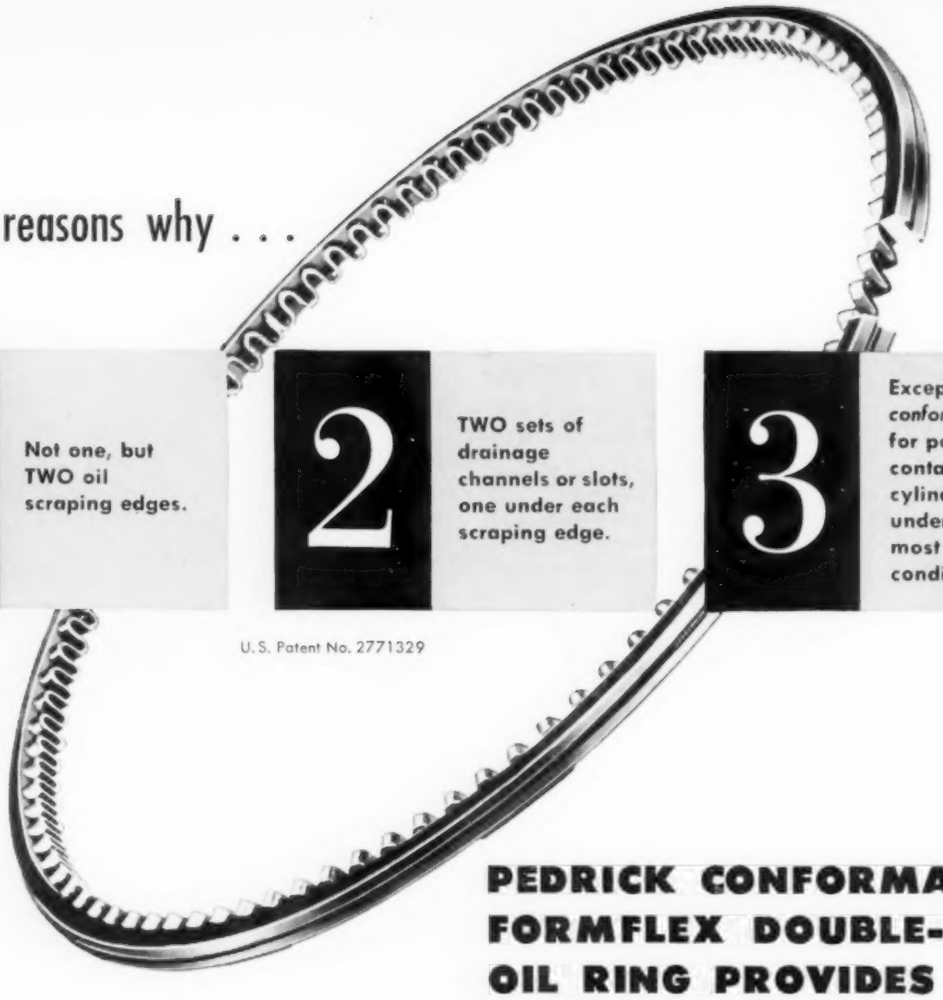
3 good reasons why . . .



1 Not one, but TWO oil scraping edges.

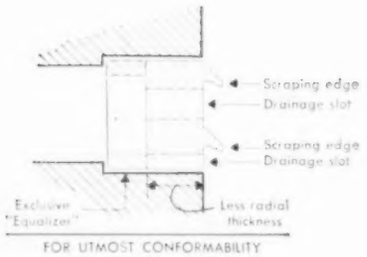
2 TWO sets of drainage channels or slots, one under each scraping edge.

3 Exceptional *conformability* for positive contact with the cylinder wall under even the most severe conditions.

U. S. Patent No. 2771329

PEDRICK CONFORMABLE FORMFLEX DOUBLE-DRAIN OIL RING PROVIDES IMPROVED OIL CONTROL

. . . especially on pistons with oil drainage through the grooves instead of below the grooves.



FOR UTMOST CONFORMABILITY

Users find the Pedrick FORMFLEX Double-Drain DD8 oil ring provides quicker, more effective drainage, giving improved performance in all piston groove designs. And they like its moderate cost . . . the way it installs without difficulty.

You can depend on its conformability. Pedrick's exclusive "Equalizer" steel expander ring exerts a uniform pressure all the way around the cast-iron cylinder-contacting ring. Radial thickness of the cast-iron ring is less, increasing its flexibility.

The DD8 Design Conformable FORMFLEX oil ring is just one of many designs available from Pedrick to help give you long-lived, dependable, low-cost engine operation. Say the word and our Engineering and Consulting Service are at your service. Write, wire or phone: WILKENING MANUFACTURING Co., Philadelphia 42, Pa., Tel.: SAratoga 9-3770. *In Canada:* Wilkening Manufacturing Co. (Canada) Ltd., Toronto 2.

Pedrick PISTON RINGS

PEDRICK PIONEERED *conformable* RINGS FOR BIG-BORE ENGINES

PIPE LINE PANORAMA

More Uses for Elastomer Spheroids . . . Since idea was introduced more than five years ago, uses for elastomer spheroids in pipe lines have multiplied rapidly (See Page 31). Original use was to provide effective method of minimizing and controlling mixing between batches in a products line.

Out of that initial application have come the following new uses:

- Filling and purging during hydrostatic testing
- Special line cleaning jobs
- Liquid evacuation of lines
- Purging of liquids from two-phase lines
- "Automatic" positive displacement meter proving

Look for other new uses in near future, i.e., internally coating pipe lines, blowout preventer, surge suppressor and pulsation dampener, check valve at gas compressor stations, means of locating underground piping.

1959 Labor Law: "Heaven for Lawyers—Hell for Labor and Management" . . . First major labor legislation will have major impact on construction industry. But, no one seems to be sure what specific effects will be—yet. Labor experts say even though the new law goes into effect November 14, it will be a long, long time before all the interpretations are ironed out.

As one wag put it, "The 1959 Labor Law is a Full Employment Act for lawyers."

Will Texas Eastern Build Coal Slurry Line? . . . Plan to build 350-mile, 24-inch pipe line to carry coal slurry from Consolidation Coal mines in West Virginia to major utilities in Pennsylvania, New Jersey and New York is being seriously considered. Texas Eastern would build and operate the line, thus becoming nation's first pipe line to transport products in every physical form—solids, liquids and gas. **Consolidation Coal's experience with its original 135-mile coal line in Ohio** has proved that pipe lines can ship coal cheaper than railroads.

How to Design Pipe Lines in a Hurry . . . Transco used electronic computers to prepare pipe line design for its Pennsylvania to Louisiana gas system in 27 minutes. It would have taken three days using conventional methods. Transco also is using computers to predict gas consumption a day before it reaches customers.

Pipelining in Brief . . . FPC rehearing of Transwestern's bid to build 1,800-mile gas line from Texas to California will be held October 27; it is hoped session will produce reasonable solution to FPC's 4-6 cent price cuts for gas purchased from West Texas producers . . . **On October 13,** Alberta Oil and Gas Conservation Board will consider Trans-Canada's request for new permit to export up to 16 billion cubic feet more gas per year during next 25 years, for total of 305 billion cubic feet; also, revision of present permits which would allow pipe line to increase exports from 5.87 trillion cubic feet to 6.26 trillion . . . **Ian N. McKinnon, past chairman of Alberta's Oil and Gas Board,** has been named president of Canada's new Energy Resources Board which will approve, or vice versa, all exports of the country's natural resources . . . **Industry pressure is mounting** to speed new natural gas bill that will remove utility-like federal regulation of natural gas producers; may become major issue in next session of Congress.

American
Gas Association
Project NB-13
is paying off. Technicians
devised means
of using Argon-41
in place of
ammonia as a tracer

FIGURE 1—Argon-41, which has a half life of 109 minutes was flown from the laboratory to the pipe line where it was injected as a tracer in the gas stream. It is shown here in a lead container.

How to Determine Gas Flow Rate With

By R. T. Ellington, W. R. Staats and D. V. Kniebes
Institute of Gas Technology, Chicago

A NEW TOOL has been developed for determining gas flow rates where orifice meters are not available and the ammonia tracer technique cannot be used. A short half-life inert atom —Argon-41—is proving highly satisfactory under tests. Techniques and equipment for injection, tracer preparation, transportation and detection have been developed through a research program sponsored by the Pipeline Research Committee of the American Gas Association.

The problem. High flow efficiency is a necessity in the gas transmission industry. As capital and operating costs continue to increase and the cost of gross energy transportation becomes more important to the national economy, this problem will become even more pressing. To determine the flow efficiency of a pipe line, the engineer compares the actual flow, for a given set of operating conditions and pipe characteristics, with the flow predicted by a flow equation which accurately takes all these quantities into account. Present methods for determining the actual flow with the required accuracy include proper application of orifice metering and the ammonia tracer technique. The test conditions necessary to obtain accurate results with orifice meters are well known. Conditions necessary to obtain accurate results with the ammonia tracer method are not known with the same certainty. The economies and the portability of ammonia tracer equipment make it important that as much fundamental information as possible be obtained, so that it may be used with the greatest possible accuracy.

Although the field tests of the two methods show close agreement between them, more information is needed on tracer methods. The manner in which the tracer disperses in the flowing gas, and the limits of accuracy obtainable need be determined. This will also determine whether the present method of detecting the passage of the ammonia at a given point in the pipe line is adequate.

A number of investigators have proposed theoretical relationships for the dispersion of a tracer in a flowing fluid. Accurate experimental data are needed to test these relationships.

FIGURE 2—Lifting tracer to transfer apparatus. Note that the quartz container at the end of the wire has been turned smoky black.

a Radioactive Tracer

Radioactive tracers are easily and rapidly detected in absolute quantities by use of relatively simple equipment. Therefore, they are easier to use to obtain dispersion data when tracers which are detected by differences in density or chemical properties.

Summed up, the problem is: (a) to develop a technique for use of a radioactive tracer for pipe line flow measurement; (b) to utilize this technique to obtain accurate field test data; (c) to analyze the test data to determine the effect of flow distance, pipe diameter and flow rate on the dispersion of the tracer; and (d) to suggest methods of improving the utilization of ammonia as a tracer. This will give a new tool for pipe line use and improve the results obtainable with an important existing tool.

Review of Previous Work. When a tracer, which differs in some property from a flowing fluid, is injected into a line, the region in which the tracer is concentrated moves downstream as a *streak line* during constant injection, or a *zone of concentration* for a short period of injection. Use of tracers to investigate various aspects of fluid flow dates from Reynolds' colored filament experiments and frequent use of dyes to trace flows in open channels. Such work on pipe flow dates approximately from the turn of the century.[8, 17] Many different tracer properties have been utilized: (a) electrical conductivity, (b) density, (c) thermal conductivity, (d) chemical reaction, (e) radioactivity measurements, and (f) visual observation. In several cases new methods have been developed to meet the needs of specific industries.

Since World War II, several new techniques have been employed. The use of a tracer to obtain flow rates on long transmission lines at points away from orifice meters has become an important tool of the natural gas industry. This permits determination of the flow performance or efficiency of any section of a pipe line, so that cleaning operations may be undertaken in the proper area if low efficiency values are obtained.[1, 14, 21]

Improving the accuracy obtainable with this method is important because measurement of flow efficiencies with errors of less than one percent are necessary to detect improvements of 1 to 5 percent with acceptable accuracy.[4, 16] Anhydrous ammonia is the tracer which has been used with greatest success; detection has been effected by passing a bleed stream of gas from the pipe line through phenolphthalein or methyl red indicator solution.[1, 14, 21] Some tests have been carried out on refinery gas lines with hydrogen as the tracer.[8]

Detection of the interface between slugs of different products in oil lines by use of radioactive tracers has been developed and reduced to operating practice.[5, 9] A useful tracer is triphenylstibine tagged with Sb^{124}.

Tracer Movement. If the characteristics of flow in pipe were such that the blob of tracer, whatever its shape, did not become distorted or mix with the material in which it is suspended, very accurate flow rates would be obtainable by this method. These effects must be present, however, and must be further clarified before full use can be made of tracers for some applications. *For example, the stream velocity varies over the cross section of the pipe, and part of the injected material starting near the centerline of the pipe will be carried downstream to the measuring point faster than parts originally near the wall.*

In 1953, Taylor[18] presented a mathematical analysis of the spread of a tracer in a suspending fluid moving in laminar flow. This analysis took into account both convective or mass transportation of the tracer along the tube and molecular transport, or diffusion. He showed that the tracer concentration in a cross sectional disk is dispersed relative to a plane moving at one-half the maximum velocity by a process which obeys the same law as molecular dif-

FIGURE 3—Operator closes clamp to crush quartz container and permit the displacement of tracer into injection bomb on top of apparatus. All of these operations are carried out from a distance of three feet and with a two-inch lead shield around the polyvinyl tube.

fusion. He defined a fictitious diffusion coefficient which varies with the square of the pipe diameter and maximum flow velocity, and inversely with the coefficient of molecular diffusion.

In 1954, Taylor[19] presented a discussion of tracer dispersion for turbulent flow. In this case the virtual diffusion coefficient varies with the pipe diameter and the square root of the fluid shear stress at the wall, and inversely with the square root of the fluid density. His results predicted that a point of maximum concentration of a slug of tracer would move downstream at the mean velocity of flow of the pipe line fluid.

The results obtained by Davidson *et al.*[6] differed from 8 to 27 percent from the values Taylor's relationship would predict for smooth pipes. Kohl[11] reported a normal distribution of tracer about the point of maximum concentration when used to detect product interfaces in batch flow in oil lines. Allen's results showed some difference between the mean velocity and tracer flow times and some skewness of tracer distribution. Hull[9] made tests on lengths of oil product line up to 108 miles which showed very

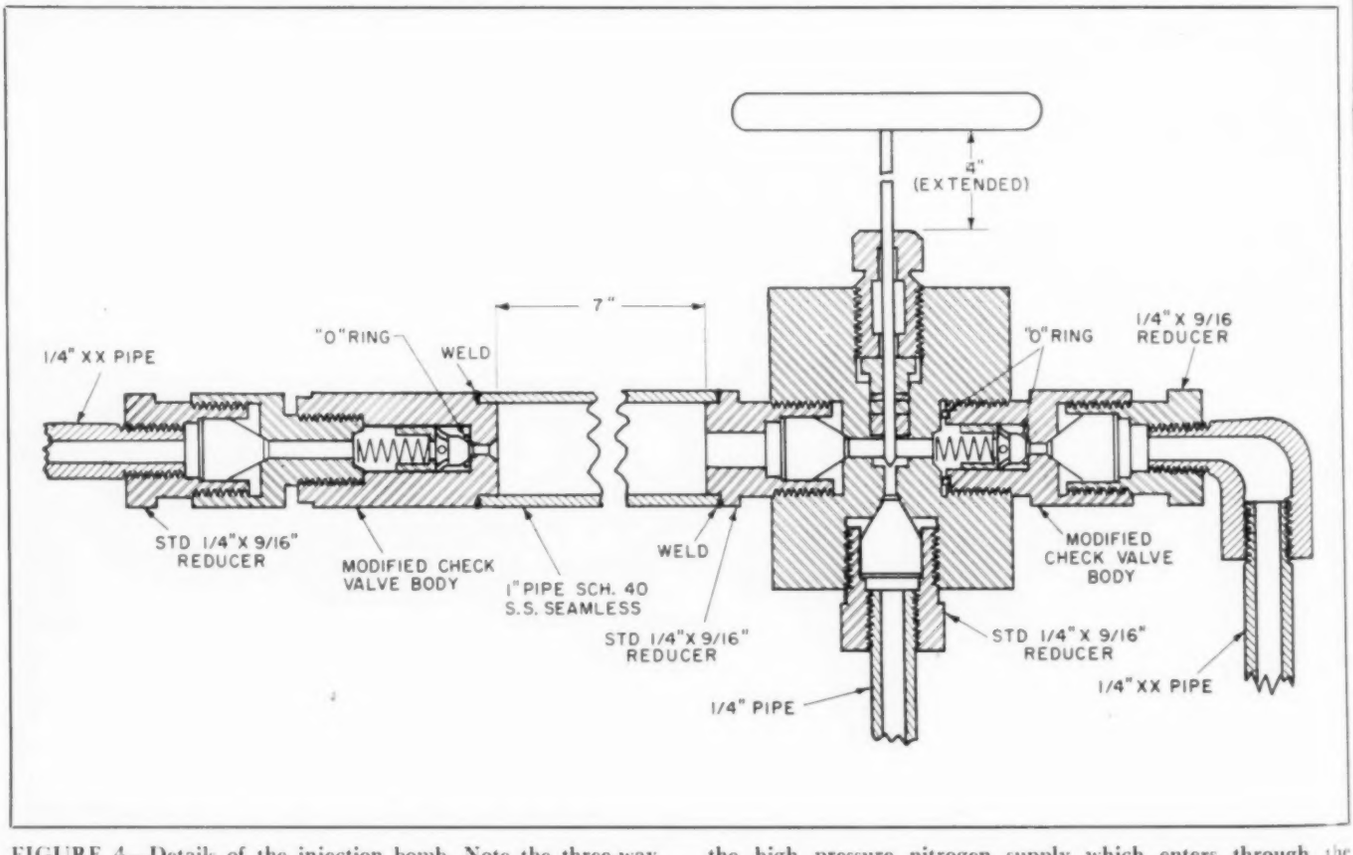


FIGURE 4—Details of the injection bomb. Note the three-way valve, the two check valves and the storage chamber. The tracer enters the three-way valve and is stored until it is mixed with the high pressure nitrogen supply which enters through the check valve at right. The check valve at the left prevents gas from backing up into the apparatus.

slightly skewed tracer distributions, but showed no check of tracer flow rate with other metering.

Past Ammonia Results. In the use of ammonia as a tracer to measure the flow rate of natural gas, agreement within one percent of flow rates by orifice meters is easily obtainable for relatively short travel distances. The theoretical relationship between peak tracer concentration and average flow rate is not known well enough despite several recent analyses,[10, 12, 13] to permit this method to be used for prime metering under the variety of conditions encountered in pipe lines.

The Reynolds numbers encountered are far greater than those treated previously, and the effects of the independent variables may be different from those indicated by previous experiments. At times ammonia is detectable for half an hour after the main slug of tracer has passed the detection point. At present one cannot be sure whether the chemical indicator changes at the time the peak concentration of ammonia moves past the detection point, or at some other point on the tracer profile.

Therefore, to permit this valuable measurement technique to be of maximum utility to the industry several aspects of its behavior need to be determined with greater accuracy. To achieve this objective a new tracer tool has been developed which can be of considerable value to the gas transmission industry.

Selection of Radioactive Tracer. To obtain data which would be adequate for analysis of tracer behavior in pipe line flow, it was necessary that a tracer material be selected which would meet the safety requirements of a utility serving the public, be detectable in absolute quantity, and have essentially the same properties as the flowing fluid. The major disadvantage in the use of ammonia is the difficulty of detecting the total amount passing a given point along the pipe at a given time. Because radioactive materials are ideal in this respect, the search turned to selection of the best radioactive atom. Consideration then had to be given to compounds containing the selected element which would meet the other requirements stated.

The literature on industrial use of radioactive gases is not extensive.

FIGURE 5—Injection tube run into the pipe line through a riser. Dip tube runs to the center of the pipe line. This is a very important feature of the injection step because of the differences in flow velocities within the pipe line.

Gemant *et al.*[7] developed techniques for the use of carbon[14]-tagged carbon monoxide and radon. These were used in static tests for finding leaks in buried pipes. They were not considered suitable for use in the planned tests because carbon[14] has a half-life of 5360 years and is difficult to detect; radon is not readily available and is also difficult to detect. Kohl *et al.*[11] reported on the use of bromine[82]-tagged methyl bromide for use in gaseous systems, and the use of argon[41] in locating casing shoe leaks in gas storage reservoirs.

Argon[41] is particularly good for use as a tracer in gas streams:

(a) Its density is only about twice that of natural gas.

(b) Its emission will not induce activity in any other material.

(c) It is chemically inert and will not combine with other materials through combustion, hydrogenation or other petrochemical or food production reactions.

(d) It has a short half-life of 109 minutes, and will decay to undetectability in normal pipe line transit times.

(e) Its emission permits detection of the absolute amount present and thus the concentration profile at any detection point.

(f) Availablity of the tracer does not present extreme difficulties.

Safety is paramount in the use of a radioactive tracer in a gas stream that will eventually be distributed for public use. In this respect it was judged advisable to even go beyond the rigid standards of exposure set by the Atomic Energy Commission.

For the type of test conducted, approximately 50 milliliters of argon[41] at atmospheric pressure was charged to the injection bomb. This was forced into the pipe by use of high-pressure nitrogen. Consideration of the dilution by mixing on injection, diffusion during flow, dilution during combustion and radioactive decay made it evident that it would be difficult to detect the tracer above normal background radiation after a few hours of transit. Even if a farm tap existed a short distance downstream of the injection point, there would be no danger of customer exposure.

It is also easy to insure safety of

FIGURE 6—Injection bomb is being mounted on the riser assembly for the actual injection.

personnel handling the tracer during transport and injection. When the tracer is in the injection bomb, it would decay completely before a person three feet away would receive anywhere near the allowable weekly dosage. Further, it is necessary that all phases of the use of the tracer be supervised by a person properly trained in health physics who can be responsible for the safety of untrained personnel assisting with the test.

Tracer Preparation. The amount of tracer needed when the sample is taken from the atomic pile is calculated from the approximate amount of tracer required to give detectability above background radiation at the detection point. For pipe walls near one-half inch thickness this should be about 0.4 millicuries. From the estimated transit time in the line section under test, the amount needed at the injection point can be determined. From this, and the total transit time from the pile to injection, the amount of tracer required initially is calculated.

The tracer is obtained by evacuating and filling with argon, separated from the atmosphere, a quartz or aluminum sample cylinder about one inch in diameter by five inches long. The final pressure can only be slightly above atmospheric. This cylinder is placed in a carrier and pushed into the pile and left for the required time at the neutron flux of the pile to give the desired amount of radioactive argon[41]. Quartz sample cylinders were used for this work but aluminum is preferred for future tests.

For transportation to the injection site, the sample must be adequately shielded to insure the safety of all personnel who may come near it. In this case lead cylinders weighing approximately 150 pounds were employed (Figure 1). Transportation to the test site may be by any private conveyance when accompanied by authorized personnel. The use of company aircraft is especially helpful.

Tracer Injection. At the test site, the capsule is transferred from the shipping container to a transfer apparatus (Figures 2 and 3), and by use of this, from the irradiation capsule to the injection bomb. In the initial tests, this transfer was accomplished by placing the capsule in a polyvinyl cylinder, Figure 3, which was then connected to the injection bomb. The capsule was crushed by closing a clamp on the cylinder, and the sample displaced into the bomb by use of mercury. The injection bomb was then connected to the pipe line riser. All of the above operations are carried out from a distance of at least 3 feet and with a 2-inch lead shield around the polyvinyl tube.

The injection bomb, Figure 4, has two check valves, a three-way valve, and a storage chamber. The tracer enters through the valve, which is then closed for the remainder of the test. The outlet check prevents high-pressure gas from the pipe line from entering the chamber and mixing

with the tracer. The inlet check prevents loss of tracer before connection to the nitrogen supply, and nitrogen from mixing with the tracer until there is sufficient pressure to really compress it. The differential required to open the outside check helps assure injection of the tracer as a small compressed slug with minimum mixing with either the nitrogen or natural gas.

Figure 5 shows the riser valve open, with the packing gland and dip tube to the center of the pipe line in place. The chains snub the dip tube in case the packing gland slips. Figure 6 shows the injection bomb in place, and the connecting union being tightened. The extra riser length keeps the tracer a safe distance from personnel making connections and operating valves.

To make the injection, valves on the gas side of the injection bomb are opened. A geiger counter is used to make a final check that the tracer is in the bomb, and is then trained on the injection tube where it enters the riser valve. The high-pressure nitrogen valve is opened rapidly and the time of injection taken as the instant the counter detects the passage of the tracer down the injection line into the pipe line flow.

Tracer Detection. Tracer passage was detected through the pipe wall by use of a scintillation counter. This instrument was placed in a shielded tube to eliminate as much stray radiation as possible. This also served to reduce pickup from the tracer before and after it reached a point directly opposite the detector. Figure 7 shows the shield mounted on a saddle which lies on the surface of the pipe keeping the probe trained on the pipe axis. Also shown are the scintillation counter and a rate meter, whose output feeds to a tape recorder and a strip-chart recorder. The cooperating company made an unusually large excavation in this case. Actually all that is needed is sufficient room to lay the saddle on the pipe coating. The detection equipment is also more elaborate than necessary for routine work. A portion of the strip chart from one field test is shown in Figure 8; it shows how precisely the tracer concentration profile is detected.

Preliminary Research. The radioactive tracer injection and detection techniques were proved out during the winter of 1957 at the Crawford

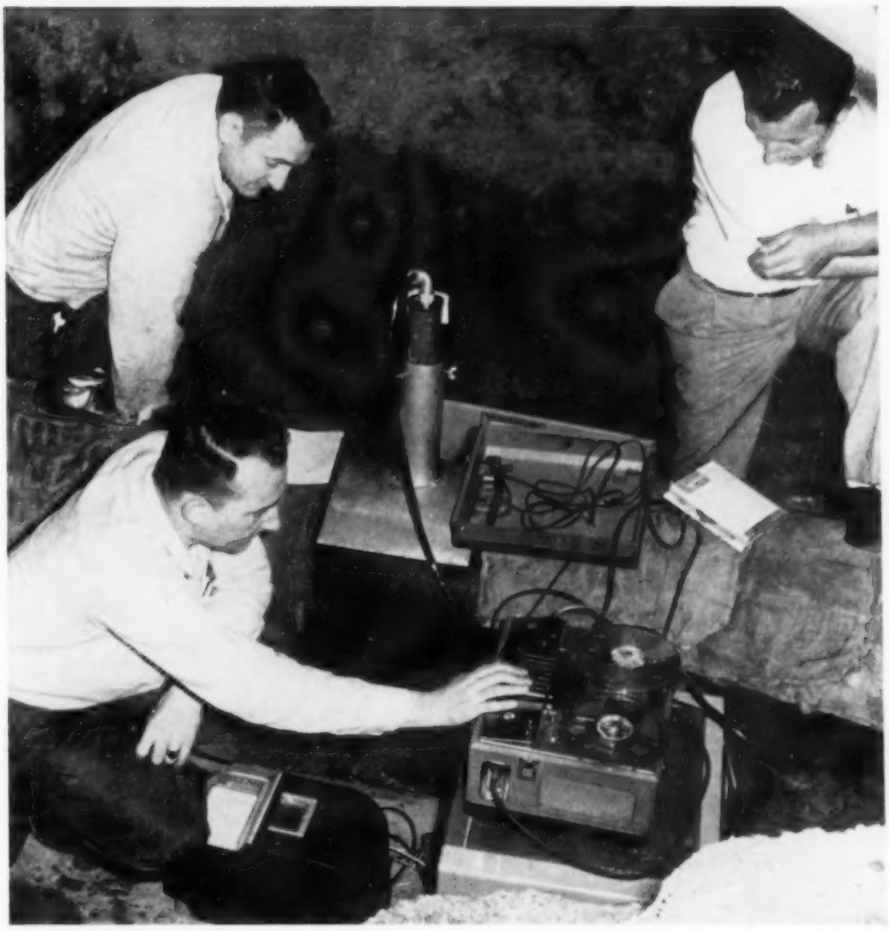


FIGURE 7—Radioactive tracer detection equipment in place on the pipe line. Pickup is in the shield mounted on the pipe line at the left. This shield reduces stray radiation and holds the scintillation counter on the proper axis.

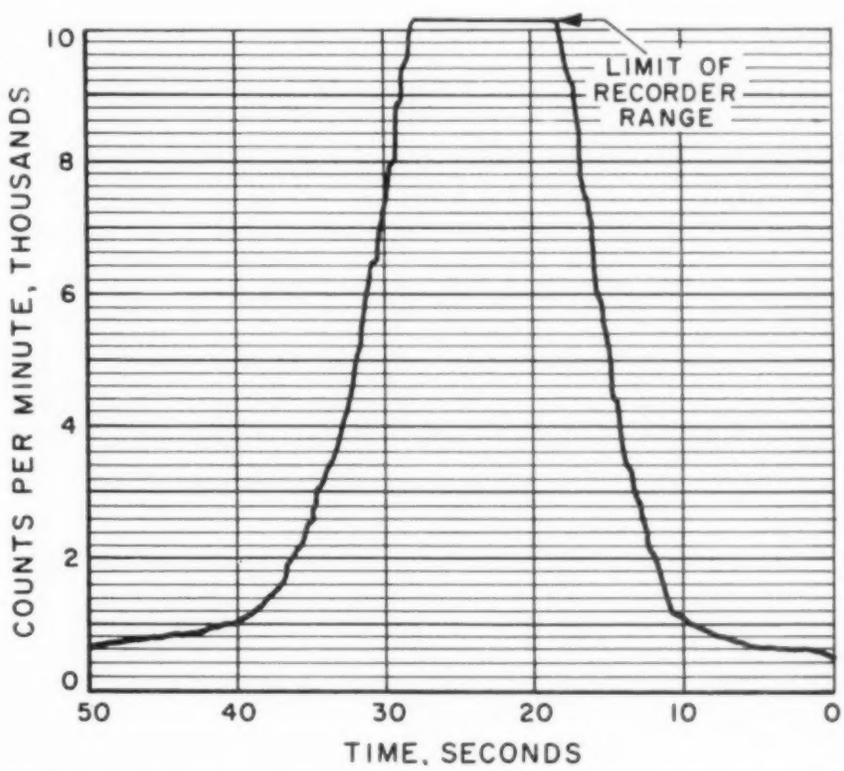


FIGURE 8—Portion of the strip chart which shows how precisely the tracer concentration profile is detected.

Avenue pilot plant of the Institute of Gas Technology. A 15-foot section of 26-inch pipe was fitted with a riser, buried and pressured to 600 psig, then all injection and detection operations were carried out on the live line.

On June 5, 1958, through the cooperation of the Panhandle Eastern Pipe Line Company, argon injection tests were conducted concurrently with ammonia tracer tests and were monitored by use of orifice meters. The tracer was irradiated at the Argonne National Laboratory, picked up and flown to southern Illinois by IGT personnel in a rented aircraft. A company car was used to complete the journey. Both injection and detection were effected without difficulty.

What the Results Mean. Flow rates in MMscfd, as determined by the three independent means are given in Table 1.

TABLE 1—Comparison of Orifice Meter and Tracer Flow Rates From June 5, 1958 Tests

Test No.	Tracer	Q_b Tracer	Q_b Orifice Meter
1	NH_3	253.61	260.56
2	NH_3	254.11	256.56
3	NH_3	254.54	256.34
4	NH_3	254.21	256.71
1a	Argon	254.01	256.59
5	NH_3	253.64	256.67
2a	Argon	254.51	257.45
6	NH_3	253.66	257.30

From this it can be seen that there is good agreement among the methods. Detailed analysis shows that the rate measured by the orifice meter corresponds to a point ahead of the peak argon concentration. This is at variance with the predictions of the significant work of Taylor.[19] This point, especially, needs to be investigated further, as do the effect of pipe diameter, flow distance and flow rate on tracer dispersion.

Future Possibilities. A new tool has been developed for the pipe line industry. Argon[41] is a very satisfactory tracer for use in natural gas flow. Results of the exploratory tests indicate that further work is necessary to increase the accuracy of the results obtainable from tracer flow measurements. Some of this work is planned for 1959.

With improvement, this method should be usable for spot checking of orifice meters. It should also enable more accurate results to be obtained by use of ammonia tracer. A quantitative method of detecting the ammonia may eventually be desirable.

ACKNOWLEDGMENT

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Dr. Rex. T. Ellington is assistant research director and chairman of the education program of the Institute of Gas Technology. He was graduated from the University of Colorado in 194; studied under IGT fellowships for master's degrees in both chemical engineering and gas technology which were awarded in 1949. He received a Ph.D. from Illinois Institute of Technology in 1953. During World War II he was an electronics officer in the air arm of the U.S. Navy. Prior to joining the staff of IGT he worked in the engineering department of the Boston Gas Co. for a year and with the Chattanooga Gas Co. for two years. He has been with IGT since 1954. Ellington is an active member of the AIChE, AIME and the AGA.

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Rubber Balls Take On New Pipe Line Jobs

Removal of liquids from offshore gas gathering lines, filling and purging new lines after construction, "automatic" liquid meter proving and special cleaning tasks are some of the more interesting ones

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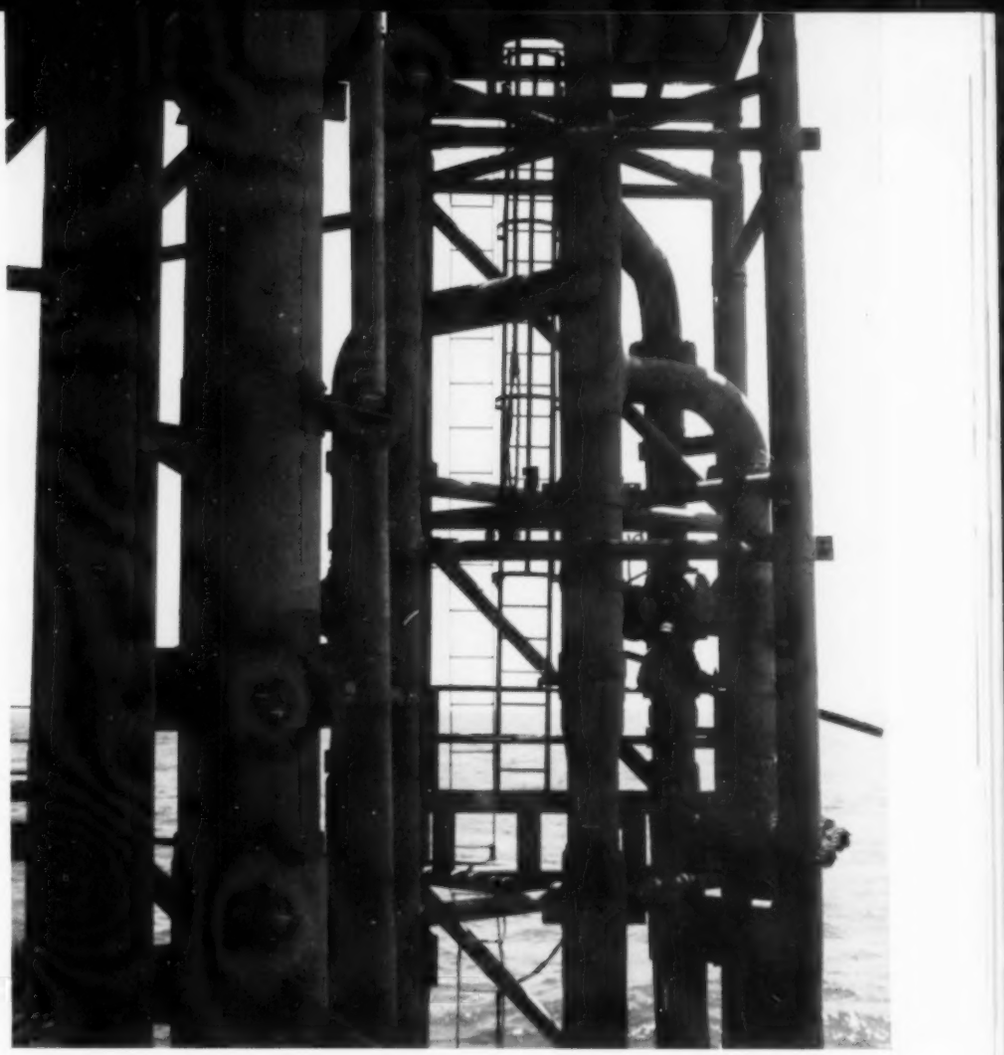


FIGURE 1—To carry out an onstream pigging program of offshore gas gathering lines subsequent to two-phase operations Transco made use of this specially designed riser. Three separate 16-inch feeder lines ell into the header near the top of the 20-inch portion. Spheroids from any of the producers lines to this junction platform enter the top of the header, drop vertically down it, pass into the reducer and on through the 16-inch line to shore. In this way spheroids are passed through the system without interruption of flow to remove surplus liquids.

ORIGINALLY, the application of elastomer spheroids to pipe line problems came as a result of research on the problem of reducing interfacial mixing in a products line.[1] But because of high efficiency as a separating mechanism, spheroids are now being used in a wide variety of pipe line applications.

Pipeliners, who have a reputation for a fertile imagination, are using the balls for filling test sections, purging lines following construction, removing liquids from offshore gas gathering systems, cleaning pipe lines with a solvent wash (run back and forth between two or more spheres), liquid meter proving by the "measured mile," "the endless mile" or "portable bidirectional" methods and radioactive tracer flow studies. And, unless we've misunderstood pipeliners, there will probably be more new ideas before this article is in print. There are many examples of recent successes.

In Line Cleaning Progress. Transcontinental Gas Pipe Line Corporation reported that the cleaning of their South Jersey 16-inch and 12-inch line from Trenton to Woodbury was a problem because confined areas necessitated their using some 20-90° weld ells in the construction. They attempted to use conventional type pigs for cleaning; these required excessive pressure at the ells and shot at high velocity from one ell to the next, rupturing several ells. This attempt was discontinued.

Work was resumed in the 23 miles of 12-inch line with a sphere. After it had been run through the line 14 times, during which operation the foreign materials at the end of the line were removed with a portable type dust scrubber, the line was cleaned to their satisfaction; Transco had recovered approximately 1,000 pounds of sand, mill scale and other foreign materials.

They are now planning to use two 36-inch diameter spheroids in a cleaning operation following the completion of their Caldwell loop in New Jersey.

Industrial Gas Supply Corporation[2] described the problem they had in cleaning sand (deposited by a breakdown of separation facilities on a gas well) from a 22-mile section of 14-inch line. Two conventional pigs required a 400-pound differential to move and seemed only to loosen the accumulations of apparently encrusted deposits. Each pig brought in about 1½ barrels of sand. A sphere was finally run through the line, using about a 10-pound differential; about

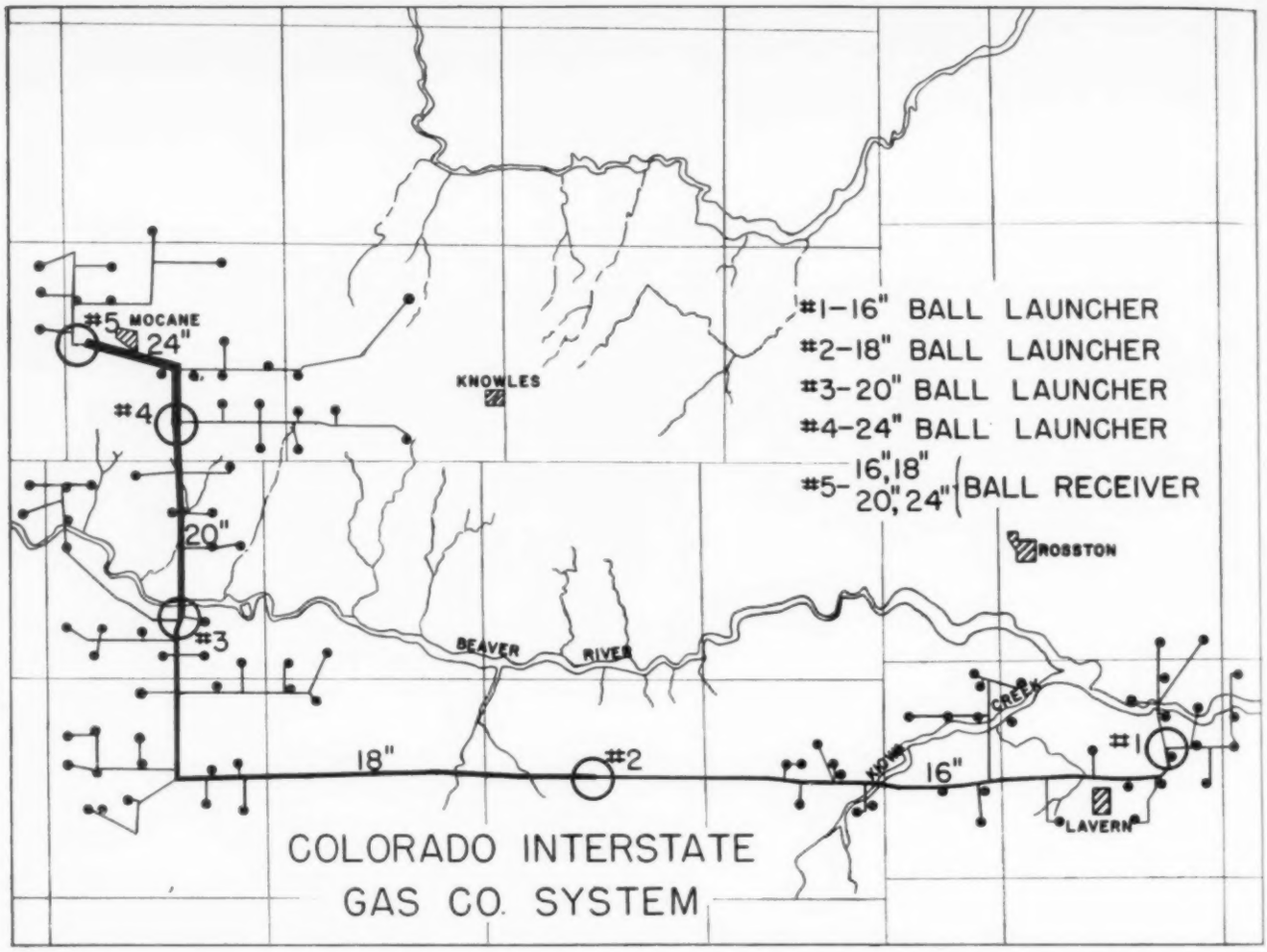


FIGURE 2—Onstream pigging of multi-diameter lines to be tried by Colorado Interstate. In succession, spheroids of 16-inch, 18-inch, 20-inch and 24-inch will be automatically launched at points 1, 2, 3 and 4. In each case the larger spheroid will be launched in the line of the proper diameter following the smaller spheroid emerging from the upstream line. Accumulated liquids will be swept along ahead and recovered at Mocane station along with the four sized spheres.

20 barrels of sand and a large amount of water was brought in. A second sphere brought in only 5 gallons of water and a trace of sand.

In experimental operations, Panhandle Eastern Pipe Line Company employed a unique procedure to clear materials such as compressor oils, loose scale and foreign matter from a section of 24-inch line. First efforts involved an 8-mile section of line; they essentially consisted of washing the section with a slug of approximately 12,000 gallons of natural gasoline confined on each end by a 24-inch spheroid. At the end of the 8-mile section the slug was stopped; the line was blown down and the slug with spheres blown back to the originating point. This procedure was repeated several times.

In subsequent tests a wire brush and rubber disc-type cleaning scraper was inserted in the approximate center of the slug of distillate between the two spheres. This slug satisfactorily passed through the line in both directions; supervisory personnel found that having this brush type scraper in the slug of liquid cleaned more effectively than when they used only the two confining spheroids by themselves. Visual inspection of the discharged material indicated that the cleaning operation was successful; Panhandle expects to do further work with this technique.

Reports indicate that the spheroid is not as effective as a scraper-pig in bringing dirt and foreign matter out of a new, dry line, but, that it can be quite effective when the turbulent effect of water or other liquid ahead of the sphere is used to keep the foreign matter agitated and in suspension during travel. Where spheroids are used in two-phase lines for sweeping liquid frequently or as liquid separators in multi-product lines, their repeated sweeping of the line should be quite effective as a means of continually bringing out fine scale and rouge.

Liquid Purging From Two-Phase Lines. In 1957 Transco laid 7½ miles of 16-inch line off Cameron Parish, La., to connect gas purchased from John W. Mecom, a producer. They were aware that under certain sea conditions they would be confronted with two-phase operation from the offshore installation to landside facilities when the producer would not be able to load barges at his platform. This causes storage tanks to be overtaxed, forcing them to introduce liquid into the stream of gas coming onshore and to remove the liquid at that point by separator facilities.

After sea conditions return to normal to maintain highest efficiency possible on all the lines, it is necessary to remove liquids left in the lines.

A spheroid launcher was installed on the Mecom platform, along with a receiving trap onshore, Transco has found it possible to run a spheroid onstream and sweep the line free of liquid. This operation has been accom-

pushed numerous times on this 7½-mile line with satisfactory results. A single spheroid passed through the line has removed in excess of 25,000 gallons of distillate as gaged by shore tanks.

Special Risers Pass Spheres

With completion of Transco's 16-inch line connecting offshore gas supplied by Pure, Superior and Union Oil Companies, they were again confronted with the problem of loss of efficiency due to distillate accumulation, and used the spheroid to purge the line. Figure 1 shows in detail the novel design of the 20-inch diameter vertical spheroid transfer header at the junction platform. Three separate 16-inch feeder lines ell into the header near the top of the 20-inch portion.

By means of this arrangement, Transco can run a spheroid from any of the producers' platforms to this junction platform 16 miles offshore. Incoming spheroids from any line enter the top of the 20-inch header, drop vertically downward in it and through a reducer to the 16-mile line to shore. Spheroids are passed through this system without interruption of flow and remove all surplus liquid accumulation.

On Stream Pigging of Multi-Diameter Gas Lines. Colorado Interstate Gas Company is currently planning still another scheme for removing and recovering condensed liquids by on-stream pigging with spheroids. Main trunk line of their natural gas gathering system in the Oklahoma Panhandle is shown in Figure 2. The line starts at point 1 as 16-inch, increases at point 2 to 18-inch, at point 3 to 20-inch, at point 4 to 24-inch and ends at point 5.

They plan to install appropriate size launchers at points 1, 2, 3 and 4 and a spheroid receiver at point 5. A 16-inch spheroid will be launched at the beginning of the 16-inch line when pressure drop indicates low line efficiency; this will sweep the liquid into the 18-inch line at point 2. When the 16-inch spheroid enters the 18-inch line, it will cause an 18-inch spheroid to be launched behind it. Similarly, a 20-inch and then a 24-inch spheroid will be launched behind the preceding train of spheroids as they pass those respective launchers. Each size spheroid will sweep its particular carrier line and push the smaller spheroids ahead of it, along with the accumulated liquids, into the station site 5 where a receiver will trap the spheres; a separator will collect the liquids.

FIGURE 3—Spheroid launcher for "short measured mile" at Shell's Argo, Illinois terminal permits remote launching of a supply of spheroids for onstream meter proving.

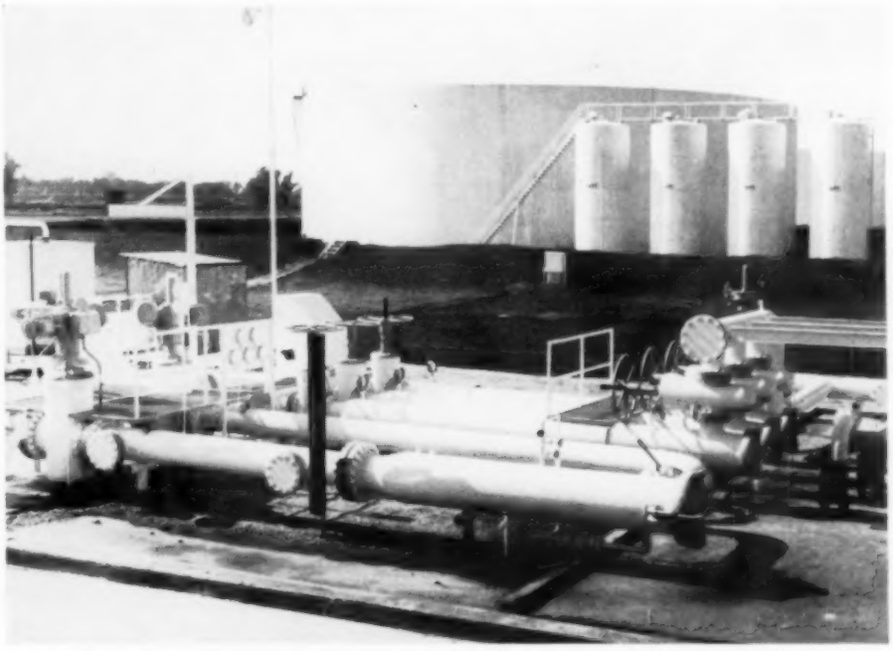


FIGURE 4—Spheroid receiver at end of "short measured mile" at Argo catches the spheroids at end of the meter proof run. Spheroids displace 68 barrels to the final indicator; it takes a little over one minute per meter proof at a line flow rate of 3600 barrels per hour.

It is planned to construct each launcher large enough to hold enough spheroids for some weeks operation with little or no attention. Colorado Interstate hopes to have this installation completed this year and will rely on experimentation to dictate future refinements.

Advances in PD Meter Proving. Interest in the basic "measured mile" method of proving high capacity pipe line meters first reported[3] in 1954 has increased; the general procedure for this mechanical displacement type proving is expected to soon become an API Standard.[4] Among the foremost users of the procedure for long lines are Texas Eastern Transmission Corporation and Shell Oil Company.

First installations of these "measured miles" (or more properly measured "meter prover sections") made by Shell Oil Company used as the displacing piston a simple "dumbbell type" scraper with no rattlers or

FIGURE 5—"Endless mile" meter proving facilities use spheroids in fast meter proof by Wolverine Pipe Line. The spheroid is placed in the prover loop section and remains there for repeated use upon demand. Proving is inaugurated by push button; the spheroid drops through the power operated valves and into the lower loop at its upstream end. These facilities are used to prove two 8-inch meters ultimately expected to measure at a rate of approximately 5,500 barrels per hour.

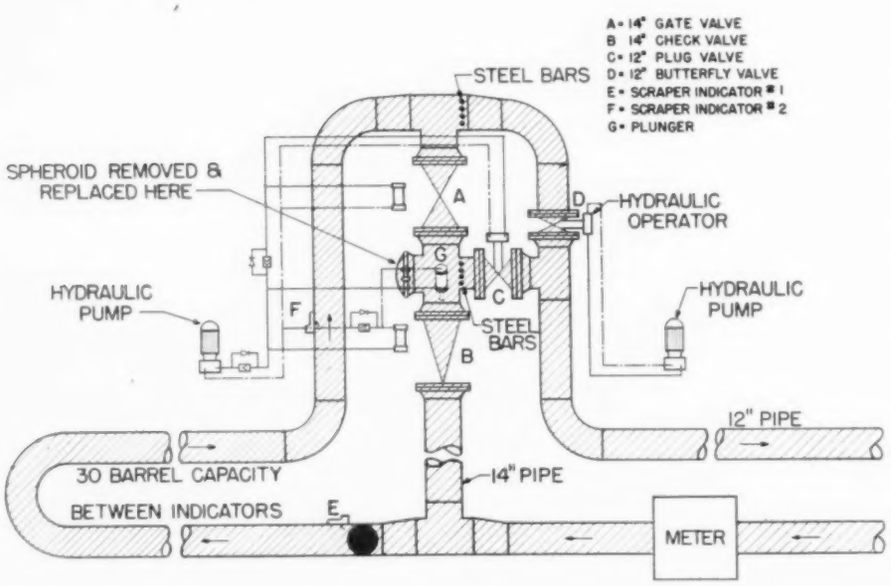


FIGURE 6—Schematic drawing of Shell's planned automatic proving loop pointing out modifications of "endless mile" facilities shown in Figure 5. Previously, when spheroid reached steel bars at top of prover loop it had a tendency to want to remain in the flowstream. For this reason the valves and controls at C and D were added along with the steel bar catcher to the left of valve C in order to better control the spheroid movement and recovery at G. The sphere stops at the lower jail bars at point G and rests on the hold pin until signalled to start a new cycle.

brushes. Such scrapers were quite satisfactory from an accuracy standpoint but were cumbersome to handle, high in maintenance cost and had relatively short life. Our experimental work with spheroids demonstrated that their ability to seal against the internal pipe wall was as good or better than the scrapers we had been using, so long as they were inflated within the mechanical seal range. This led to the conclusion that they should work well as the free piston displacing device in meter prover sections; subsequent testing conclusively demonstrated their utility. All of our 8-inch and 14-inch early type long measured miles are now using neoprene spheroids on a routine basis.

In 1958, we made the first modification of the earlier concept of the "measured mile" by simply decreasing the displaced volume, installing a remotely controlled launcher and using the 14-inch spheroid. At Shell's Argo, Illinois Terminal, the original scraper launching site was dismantled and the spheroid launcher of Figure 3 installed within the terminal property approximately 68 barrels upstream from the final scraper indicator. With this facility, we can remotely and individually launch a reasonable supply of spheroids, let them displace 68 barrels to the final indicator and catch them in the receiving trap of Figure 4. One spheroid is used per meter proof; this is accomplished in a little over 1 minute at our usual line flow rate of 3,600 BPH.

"Endless-Mile" Prover Loop. A still later development in the use of a spheroid for meter proving has been undertaken at the receiving meter station on the Wolverine Pipe Line at Marshall, Mich. Figure 5 shows the proving facilities for two 8-inch meters which ultimately are expected to measured at a rate of approximately 5,500 BPH.

This is again the displacement method of proving and could perhaps be dubbed the "endless mile," for a spheroid is placed in the prover loop section and remains there for repeated use upon demand.

Meter proving with this scheme is inaugurated by push button which causes the spheroid to drop down through the two power operated valves in the crossover from the downstream end of the prover loop to its upstream end. This is best illustrated in the schematic diagram of Figure 6. The spheroid passes the first indicator E and then the second indicator F and in so doing displaces the prover volume of 30 barrels. The sphere is then extracted from the stream at the steel bars at the top of the overboard and falls down into the

crossover ready for reuse upon demand.

The only trouble with the installation as originally made is that it wouldn't work satisfactorily at rates of flow in excess of 2,200 BPH because the spheroid wouldn't fall down off the jail bars at the top of Figure 6. In general, we have found, not only here but in the design of our fully automatic spheroid by-passes at pumping stations, that the spheroid does not want to leave the stream at high flow rates; it is necessary to construct special devices or valving systems to make the spheroid behave as desired.

We are therefore now in the process of modifying the piping to conform to the schematic of Figure 6, i.e., adding 12-inch valves C and D. In operation, valve C will open and valve D close, and the flow of fluid down through the top valve of the crossover will bring the sphere down with it. The sphere will stop at the lower jail bars at point G and rest on the hold pin where it will wait for the release cycle to start. With this arrangement it will be possible to have valves A, C and D wide open to bring part of the stream over the sphere and warm it up in winter to line temperature before it is launched through valve B.

All of these valves are power operated and electrically sequenced so that the meter proof is fully automatic after signal and requires only about 25 seconds running time at the normal 4,400 BPH flow rate.

Photo-electric Meter Readers. Photo-electric tachometers on the meters and a digital counter will be used for high resolution of meter readings, thus enabling the low volume prover section and the resultant cost saving in pipe in the loop.

A special meter register system is being developed for this location which will accumulate the registration of the two receiving meters, temperature compensate it, transmit it to the office, permit adjusting it to a meter factor of 1.0000, read out visually, print out automatically every hour or upon demand and print out run ticket by means of dual printers for all batches.

Portable Field Meter Provers. A recent development in the proving of oil field meters is the portable bi-directional type meter prover[5] employing a single, permanently installed spheroid. The first unit constructed by

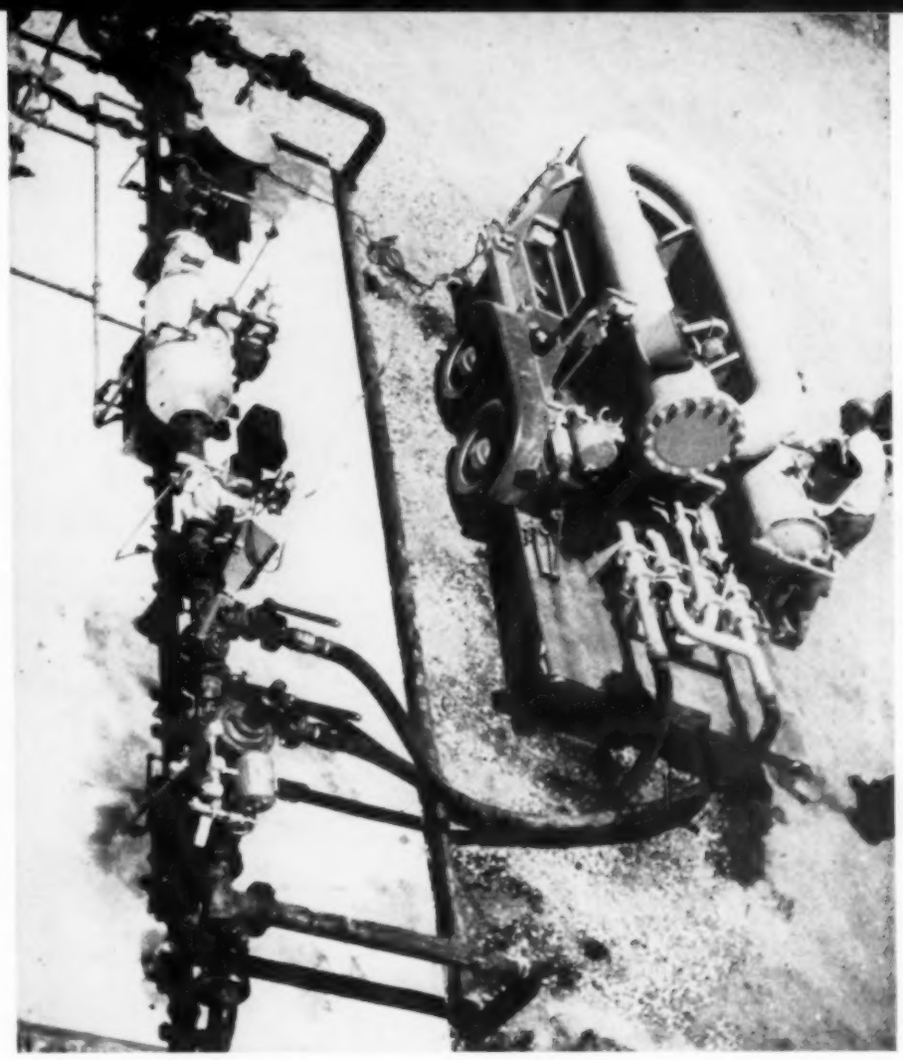


FIGURE 7—Portable bi-directional displacement meter prover shown in operation in California. Prover is built for highway movement and oil field automatic custody transfer service. It consists essentially of four straight lengths of 12-inch O.D. pipe joined at ends by means of 180° return bends; all nested compactly on a trailer mount.

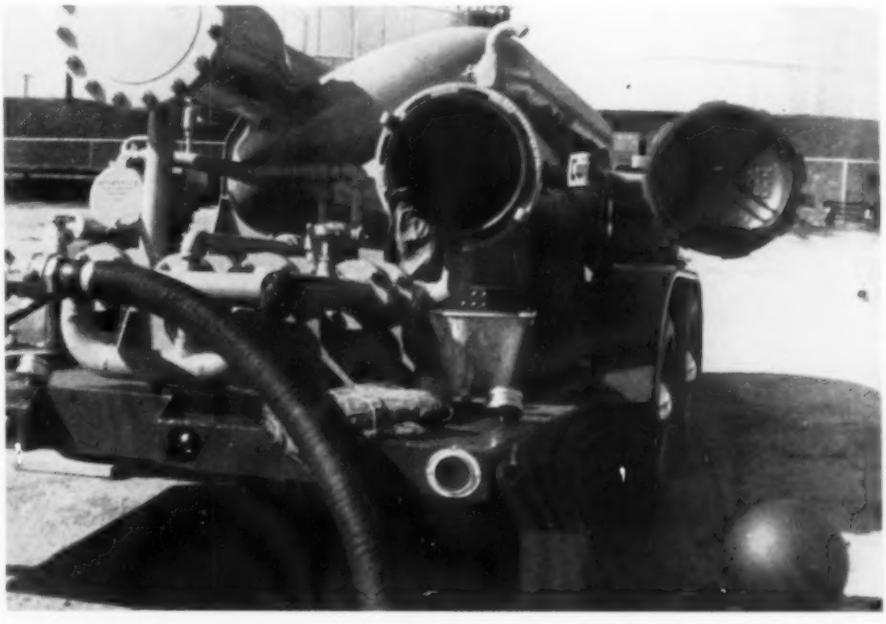


FIGURE 8—Close-up of portable LACT meter prover shown in Figure 7. Spheroid on the ground is sized to 12.4-inch diameter; it reciprocates from one end of the prover to the other between pig signals. By means of appropriate valving a meter proof can be run in either direction of movement. Unit is equipped with a digital counter and photo-electric tachometer.

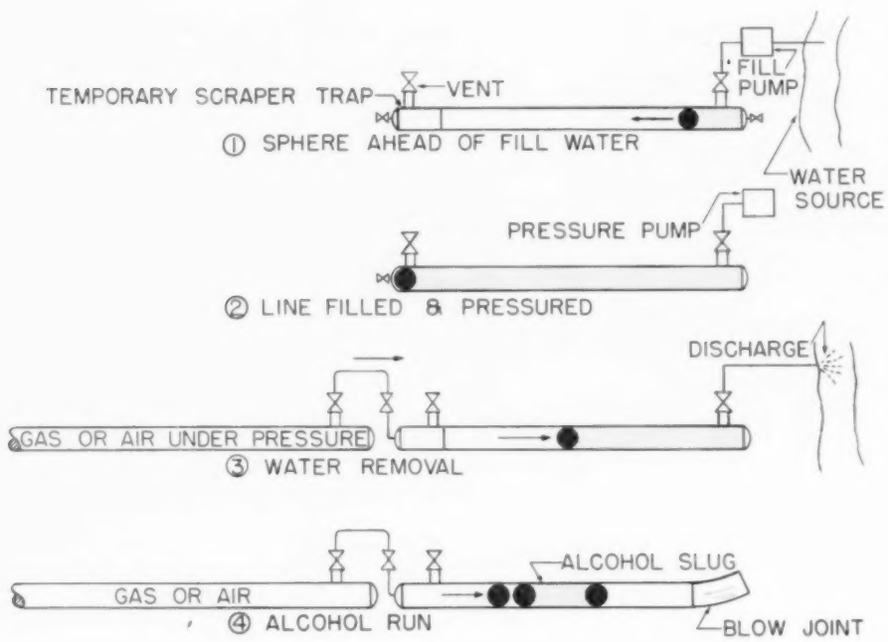
Shell's West Coast Pipeline Department is shown in Figure 7 in use in the San Joaquin Valley Lease Automatic Custody Transfer area of California. Figure 8 shows the unit in close-up during an internal inspection of the bore of the prover and the condition of the neoprene spheroid.

The prover is ruggedly built for highway and oil field portability; it consists essentially of four straight lengths of 12-inch O.D. pipe joined together at the ends by means of 180° return bends and nested compactly on the trailer mount. One end is closed with a blind flange while the other uses a quick make hinged cover. The spheroid is sized to 12.4-inch diameter and is caused to reciprocate from one end of the prover to the other between two bi-directional pig signals. By means of suitable valving built on to the unit, a meter proof can be run with either direction of movement of the sphere.

The unit is equipped with a digital counter and a photoelectric tachometer arranged to be driven by the meter being proved. Over 100 calibration runs were made to determine the prover's repeatability of displacement and no runs were at variance with the average displacement by more than 0.11 gallon. Displaced volume has been certified by the County of Los Angeles Sealer of Weights and Measures at 228.77 gallons giving the prover a well established maximum error of repeatability of 0.0005.

The unit has facilities for assuring that all the air is blown from it, a pump for emptying the cylinder when required and safety features compatible with the work it must do. The original spheroid is still in excellent condition; there is so far no way to determine its life expectancy. This spheroid type prover has many advantages in this crude oil service and there seems to be no reason why one could not be employed for many other types of liquids.

A model similar to this prototype, but having a 16-inch diameter spheroid and a 10-barrel displacement, is soon to be constructed; land holders and other oil companies have given the unit good acceptance. It is planned to use these devices also for checking the calibrated volume of barges.



TYPICAL HYDROSTATIC TESTING OPERATIONS

FIGURE 9—Steps in hydrostatic testing of line making use of neoprene spheroids. Schematic shows filling, pressuring, water removal and alcohol slug runs to dry line. Advantages claimed for the sphere in this service include easier insertion into line, less "leak-by," better water removal and ability to run spheroids in either direction.

FIGURE 10—Among ideas for future application of the spheroids include its use in flow tests by means of a radioactive source and scintillation detector. Here is an experimental set up at a line block valve near a pump station.

Reproducibility is Good. It is important to mention that the spheroid does not displace the "absolute" volume from any of these displacement type meter provers because of "flow back" across the tight mechanical seal. But the "apparent" volume displaced is reproducible to several hundredths of a percent; the procedure is inherently as accurate as any other proving system.

Spheroid Use in Pressure Testing. Many companies have employed the spheres in hydrostatic testing of both old and new pipe lines. One of the foremost, Williams Pressure Service Company tested several hundred miles of 24-inch line in Florida for the Houston Texas Gas & Oil Corporation. Figure 9 represents a typical hydrostatic test of a section of line showing the water filling, pressuring, wate

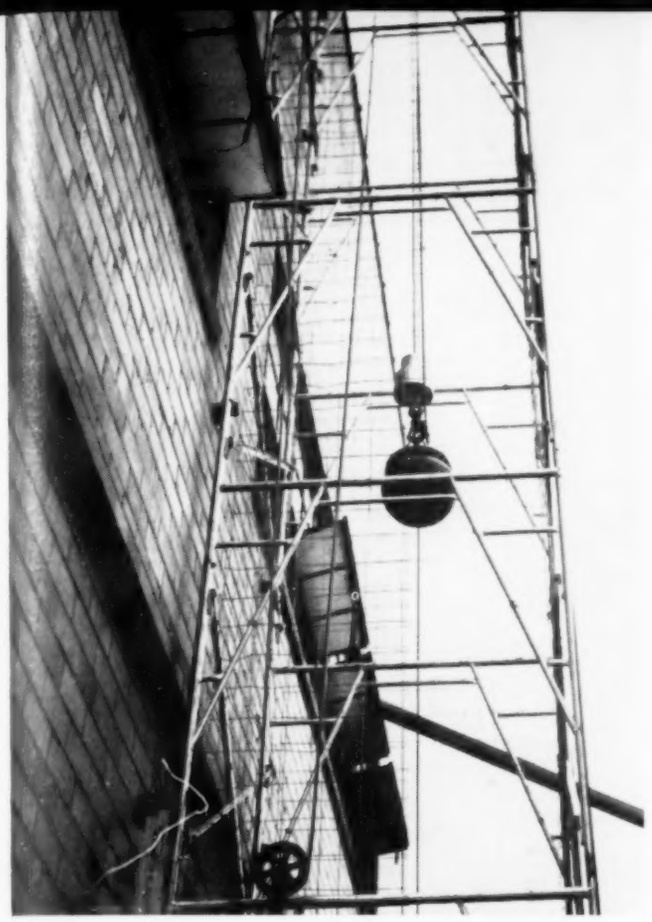


FIGURE 11—Rugged acceptance tests are made on the inflatable spheres. Spheres are over-inflated with water to a diameter 50 percent above normal. They are then lifted 60 feet in this protected tower and dropped onto a solid concrete pad to test shock resistance capabilities.

FIGURE 12—Sphere undergoing hydrostatic shock tests in tower drop as seen at point of impact. Such tests determine ability to withstand distortion under severe pipe line operating conditions.

removal and alcohol run operations.

Advantages reported for use of spheres in these operations are:

1. Inserting them in a line with no oversize scraper trap and in heavy wall pipe is accomplished by inflating the sphere after insertion. This is easier than loading a conventional scraper. Then the sphere is inflated to the desired size, deflated completely and the amount of water removed is measured. After replacing it in the line, the measured amount of water is pumped back into the sphere.
2. With the sphere properly inflated the amount of water that gets ahead of the sphere in the filling operation has been found to be considerably less than past experience had shown with conventional scrapers.
3. There is no question as to when the sphere arrives at the end of the section bleeding the air ahead of the sphere, for it completely seals the valve. In the past a conventional scraper would by-pass

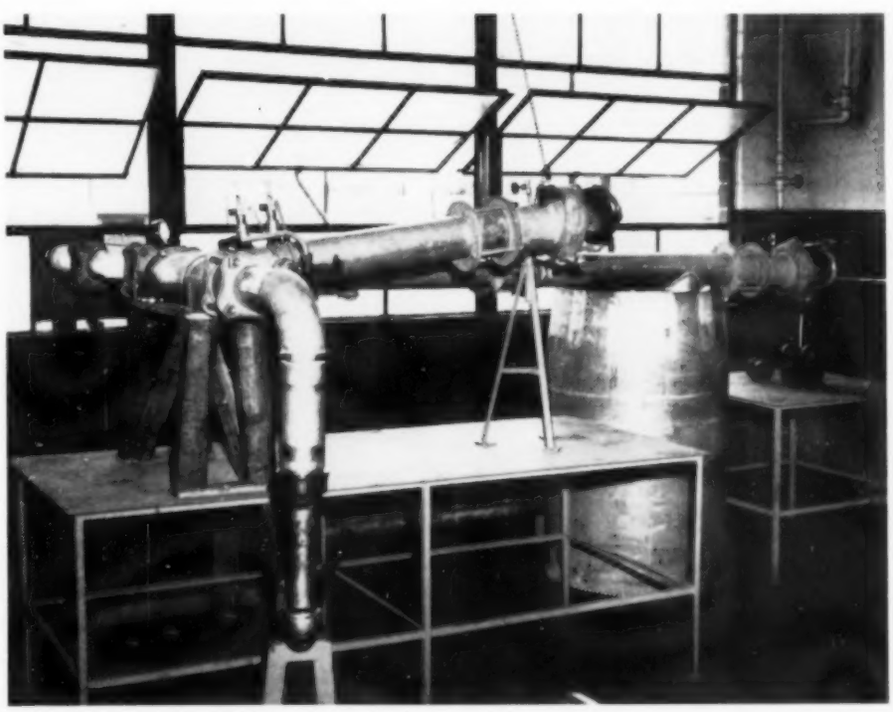


FIGURE 13—Sphere manufacturer has set up test line of 4-inch pipe 80 feet long to carry out research on sphere movement. System incorporates a spheroid launching barrel having variable elevation and provisions for several types of launching mechanisms, a receiving barrel, a liquid pump capable of pilot testing at liquid line flow rates and compressed air supply to simulate gas line service. Provisions will also be made for addition of facilities for meter proving research.

enough water through this valve to create doubt as to whether the scraper had arrived or not.

4. Biggest advantage of the sphere is that it can effectively be run in either direction. This eliminates the need for cutting the line to insert a water removal scraper and the attendant entrance of air ahead of it. Reversal of the spheroid for water removal thus prevents 'air lock' and saves much time and expense.
5. The spheroid seems to give a better seal and therefore a better water removal job than a scraper; probably because it conforms to the pipe better at bends.
6. In using alcohol to dry the line, the sphere offers a safety feature, for the mixture of methanol and air is reduced and the absence of any metal to metal contact eliminates the spark hazards.

Williams also cited these shortcomings for the sphere in hydrostatic testing:

1. Difficulty of training field personnel to properly inflate the sphere.
2. The line must be cleaned of sand, rocks and construction debris before running a sphere; the sphere will either jump them or stick at them.
3. A sphere will stop at tees or branch connections, particularly when they are near the size of the carrier line.

One gas transmission company has conducted hydrostatic testing and water displacement operations with a 10-inch spheroid which was first passed through approximately 1½ miles of 10-inch pipe and then right on through 13 miles of 8-inch pipe. The report on this unique job indicates that it worked satisfactorily and the sphere passed nicely through both sizes of pipe.

Other companies, among them New York State Natural Gas Corporation, Industrial Gas Supply Corporation, Southern California Gas Company and The Peoples Natural Gas Company, report satisfactory results in both water filling and water removal operations in hydrostatic testing.

Dewatering Internally Coated Line. The Texas Gas Transmission Company recently dewatered a 10-mile section of new internally coated 30-inch line near Clarksdale, Miss., following hydrostatic test of the section. First a 30-inch sphere, expanded to ⅜-inch larger than the pipe I.D. was run end to end; this required about 9 hours and 75-85 pounds of gas pressure. It brought out a stuck scraper and essentially all of the water.

A second sphere run through the line required only 6 pounds of gas pressure, moved at about 30 MPH, brought out a slight show of water and blew 1,300 feet across a bean batch.

Third run through the line was with a type LB-3 pig; it took 6 pounds gas pressure, traveled 30 MPH and brought out a slight show of water, a handful of pebbles and two burlap night caps. The fourth run with a slightly larger sphere, took 7 pounds gas pressure and brought out only dust. Supervisory personnel conducting this job were favorably impressed with the use of the sphere for water removal.

Special Line Evacuation Service. Several line evacuation jobs have been conducted by Shell Oil Company Pipe Line Department. One involved the necessity of removing 3,842 barrels of motor grade gasoline from a 3.2-mile section of 16-inch deactivated pipe having a check valve on the upstream end and a plug valve against a tank farm manifold on the downstream end.

A 16-inch sphere, over-inflated ¼-inch, was inserted through the bonnet flange of the check valve and pried into the line as far as possible by hand. The flange was replaced and nitrogen pressure applied behind the sphere. 100 psi pressure was required to start the sphere; it was kept moving at a displacement rate of 1,080 barrels per hour with about 12.5 pounds nitrogen pressure for 3 hours and 35 minutes until it hit the plug valve. The valve was removed to retrieve the sphere.

It is interesting to note that the tank gaged volume displaced from this line was 17 barrels greater than its calculated volume.

Progress In Liquid Batch Separation. This report so far might imply that most of the activity with the spheroid has been on gas pipe lines as a means of "sweeping" these lines of liquids. Notwithstanding, the spheroid, because of the extremely small amount of "flowback" across it, has great utility as a fluid separator in lines handling a multiplicity of liquids.

The technique of using multiple spheroids in an interfacial mixture between two products has proven eminently successful[7] as a means of decreasing the unmerchantable mixture at the end of a line. To bring this up to date, we have now brought a number of interfaces between motor grade gasoline and burning oils through our 250-mile, 14-inch product line between Wood River, Ill., and East Chicago, Ind., with as little as 250 barrels of mixture.

This is in spite of the fact that we still have not completed the installation of our automatic spheroid placement and spacing system at the source of the line; also we have a trouble spot where spheroids have been tending to "hang up" at a branch connection south of Chicago. We are correcting these conditions and hope to further improve the reported performance of the spheroidal protection system after the last piece of spheroid launching and handling equipment is on a completely instrumented and fully automatic basis.

This is essential in a protection system for liquid interfaces because, in the transition of a series of spheroids through the line, they must be properly placed in the interface and maintained there to destination or the expected protection will be quickly lost and cannot be regained.

Humble Pipe Line Company has announced[8] that they are using the spheroid to separate batches of 100 and 115 octane aviation gasoline being moved through their new line between Irving Products Terminal and Love Field. This sphere serves not only to reduce intermingling of the aviation fuels, but is also used in conjunction with a scraper indicator to indicate to the operator when the batch change arrives at the terminus.

Shell Oil Company is planning an operation somewhat similar to that of Humble; a 6-inch-19-mile line from its Wilmington, Calif., refinery to the Los Angeles International Airport, will be used to deliver 100 and 115 octane gasoline and 650-turbine fuel. Spheroids will be used for liquid separation, batch flagging and in the positive displacement meter proving procedure.

Southern Pacific Pipe Lines, Inc., reports runs of 16-inch and 12-inch spheroids on an experimental basis through their products line from Los Angeles to Phoenix, Ariz. Their pro-

dure has been to protect interfaces with two spheres only at the front and tail end; hand controlled as to placement and caught and relaunched at their intermediate stations.

SP has been able to reduce interfacial mixture from about 1,650 barrels to 1,050 barrels or in the order of 25 percent. Their problems include line shutdowns from spheres not behaving properly and having to run the 12-inch spheroids through 3 different inside diameters of pipe, making it somewhat difficult to determine the optimum inflated diameter for the spheroid. Their testing program is expected to continue along with economic studies.

Southeastern Pipe Line Company has for some time been conducting tests to determine the amount of interfacial mixture experienced in normal operation. This data is being assimilated so that comparisons can be made with similar data taken on spheroid protected interfaces which they propose to run in the Port St. Joe, Fla., to Bainbridge, Ga., 100-mile section of 8-inch line. Work will be of a pilot nature; it is their hope to be able to apply the ratios determined to larger diameter lines.

Crude Oil Batching. There has been activity among several crude oil pipe line companies directed at separating various grades of crude with the spheres. Minnesota Pipe Line Company moves three different crude oils through its 16-inch, 256-mile Clearbrook to St. Paul Park and Pine Bend, Minn., line.

To protect the 34 gravity oil from excessive mixture with the heavier 22 gravity oils it has been necessary for them to run a batching pig at the head end of each 34 gravity batch and for the past 11 months they have been doing this with a spheroid. Their experience has shown that one spheroid in an interface reduces commingling the same amount as one pig and that this provides satisfactory separation of the two crudes.

Launching of spheroids at the Clearbrook Station is a manual operation but passage through the remotely controlled Little Falls intermediate booster station is accomplished automatically by catching the incoming sphere and launching a new one into the station discharge after the station wash has been accomplished.

They report that when the average line temperature is below 60° F, spheroids are inflated to 5/64-inch over pipe I.D., but when the temperature exceeds 60° F, it is necessary to increase their size to 9/64-inch over pipe I.D. to assure that they hold their position with respect to the interface. When Minnesota has run spheroids smaller than the pipe I.D., they have found they can move forward in the stream as much as 630 barrels (or about ½-mile) from the point in the stream in which they were inserted. None of the 6 spheroids used show appreciable wear although they have traveled an average of 1,751 miles each. One sphere has traveled 3,084 miles and has not yet had to be reinflated to compensate for wear.

There are unconfirmed reports that 30-inch and 36-inch spheroids are being considered for use in a heated viscous crude line in South America, to provide mechanical separation of the widely varying viscosity materials to be pumped.

Future Possibilities. Utility of the spheroid as a fluid displacement device for pipe lines is being demonstrated in numerous operations around the country. A few typical examples of current operations, experiments and future plans have been reviewed. There are many others which might be discussed, even for instance, the experiments in which the spheroid has been used as a means of internally coating a pipe line, as a blowout preventer, as a surge suppressor and pulsation dampener, as a check valve at a gas compressor station and as a means of locating underground piping with a radioactive source in the sphere and a scintillation detector.

Uses for the spheroid will probably grow as more is learned about its physical performance, new elastomers are developed, and as the pipeliner's imagination leads him to improved operational techniques. There will be pit falls along the route of many a sphere—like their being blown through a venturi throat valve or getting stuck in a check valve or unexpectedly ending up in the suction connection of a pump. These kinds of incidents can be prevented and the spheroid can be made to serve its intended useful purposes in many pipe line operations.

If, on top of this, we can combine the increased flow efficiencies arising from slick internal coatings in both liquid[9] and gas[10] pipe lines with the resultant added wall wiping ability and longevity which the spheroid will surely have in such smooth, abrasion free lines, we may in fact have the necessary components with which to construct that "hypothetical[11] pipe line of the future."

About the Author

Maurice L. Barrett, Jr., senior engineer in Shell Oil Company's Research and Development Department at Indianapolis, Md., has had several years experience in developing the pipe line spheroid. His most recent duties have been in connection with automatic systems for handling the pipe line spheres in product separation and meter proving. Barrett joined Shell in 1939, starting as a meter mechanic, advancing to superintendent of measurement in a short time. He was graduated from Washington University in 1934, with a degree in civil engineering. From 1934 to 1939, Barrett worked for the St. Louis County Water Company.

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Tests of Pups Support "Bridging Effect"

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Product Engineering and Research Dept.
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IN CROSS-COUNTRY TRANSMISSION line construction it is frequently necessary to join thin wall, high yield strength pipe to thicker wall low yield pipe or pipe fittings. At such junctures, it is common practice to machine a taper on the end of the thicker pipe, thereby reducing the thickness to that of the adjacent thinner member, and join with a circumferential butt weld. Such joints are known as transition taper joints. They were developed as engineering expedients to permit the use of high yield pipe which gained acceptance and widespread use prior to the completion of experimental testing programs.

Now, as is to be expected, theory is catching up with practice. The result is a more critical appreciation of the significant properties of high-strength pipe itself and of piping mechanics in general. Consequently, present practices may be better evaluated and improved methods of design and construction suggested. In addition, new uses for the material and new techniques of fabrication may be brought to light, resulting in continuing advances of piping technology in many fields.

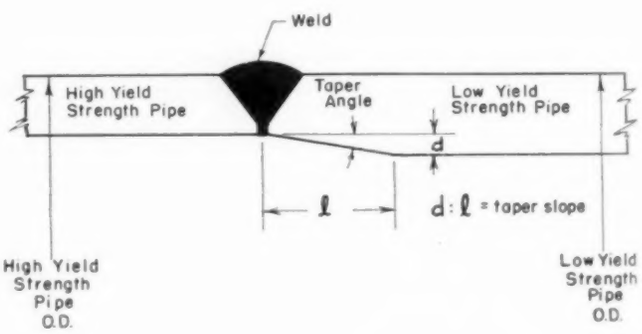
Given here are data relative to a series of static internal pressure tests run on transition tapers between 14" O.D. x .750" pipe and 14" O.D. x .500" pipe. The thick wall pipe was made of material having a yield strength corresponding to A106 Grade B minimum and the thin wall pipe was made of material having a yield strength corresponding to API 5LX52 minimum.

Transition Pieces Frequently Needed. The bulk of cross-country piping is currently being made from high yield strength material. There are, however, still many areas where use of lower yield strength pipe is necessary or desirable, e.g., at river crossings or compressor stations, etc. Because the wall thickness of transmission piping is generally determined on the basis of the yield strength of the pipe material, the wall of A106 Grade B pipe (35,000 psi) will be approximately 50% greater than that of API 5LX52 pipe (52,000 psi minimum yield).

Stress Problem. This gives rise to a problem peculiar to pipe line construction. Obviously, abrupt changes in wall thicknesses should be avoided so stress concentrations will be minimized, and this is best done by employing a very gradual taper. But a reduction in the thickness of the low-yield pipe wall could mean that membrane stress (calculated by the Barlow formula, $S = PD/2t$, as listed in ASA B31.1.8) at the thin end of the taper would exceed the yield strength of the material. For example, if the X52 pipe is designed for working pressure of 72 percent of its yield pressure the membrane stress would be 37,500 psi, which is above the yield strength of Grade B material of the same thickness.

Initially, the problem was resolved by use of transition pieces made from thick-wall, high-yield material tapered bored to provide proper matching of the welding ends. Use of such transition pieces added substantially to construction costs, however, for it involved not only the purchase of additional material but also an extra girth weld in pipe of relatively large outside diameter, usually 14 inches and above.

Further study of the problem led to the suggestion that the separate transition piece could be eliminated and the necessary taper section provided by machining the thick wall pipe itself and employing a transition type joint as shown below. Basis of this reasoning was the assumption



that the thin end of the taper is greatly reinforced by the adjacent thickwall pipe due to the *bridging effect*, i.e. the ability of the thick-wall pipe and thicker parts of the taper to support and strengthen the thin end of the taper.

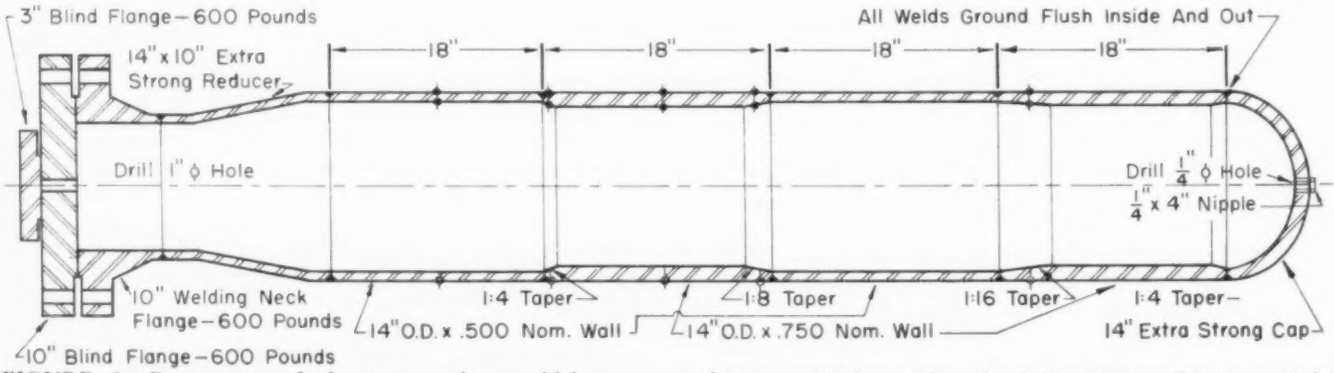


FIGURE 1—Components of the test specimen which were welded together in sequence from right to left. Welding ends had 1/16-inch lands and 37½-degree bevels. Each weld was made with five passes of 5/32-inch E6010 rod. Then external and internal surfaces of welds were ground flush with parent metal. SR-4, Type A8 strain gages were mounted at midpoints of tapers and pipe sections (as indicated by solid dot symbols). Internal gages—one longitudinal, the other circumferential—were carefully aligned so that internal and external gages were at the same location. Lead wires were brought out through one-inch hole at left.

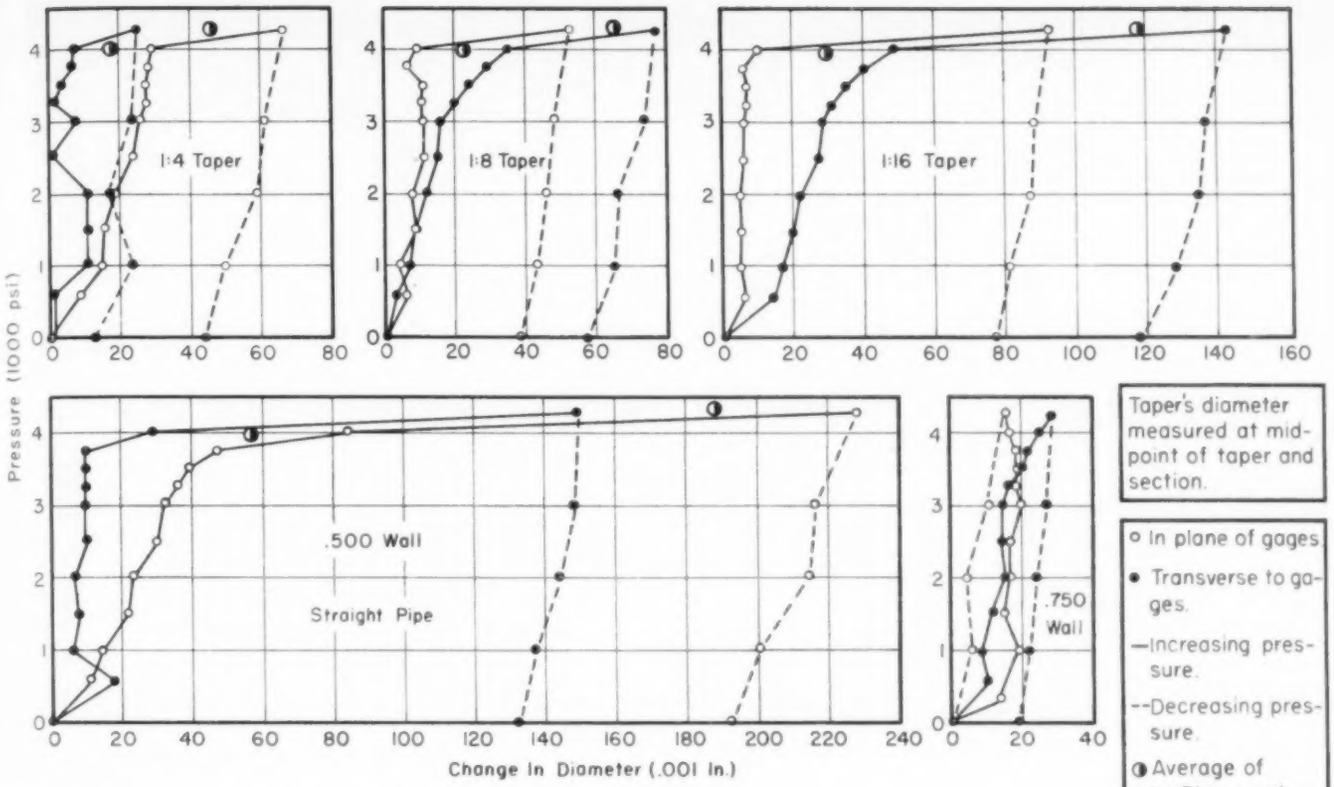


FIGURE 2—Results of diameter measurements made at the midpoints of the tapers and pipe sections plotted as change in diameter vs. pressure.

Prior to 1953, there has been no reported experimental work or direct analysis of transition taper joints. Nor did an adequate theory of plasticity of thin wall cylindrical shells exist; unfortunately, the lack of such a theory still exists. Accordingly, the authors' company instituted a testing program to: (1) determine the elastic and plastic behavior of transition tapers under simulated pipe line operating conditions, (2) determine whether the *bridging effect* permits the welding of low yield strength pipe directly to high yield pipe by use of a transition taper machined in the thicker pipe itself, and (3) determine, if possible, the optimum slope for such tapers.

Test materials. The test specimen was made up with two 18-inch lengths each of the following pipe materials as shown in Table 1.

The ends of the two 14-inch O.D. x .750-inch wall

TABLE 1—Specimen Properties

Properties		14" O.D. x 0.500"*	14" O.D. x 0.750"†
Yield Strength,‡	Longitudinal	51,400 psi	37,000 psi
	Transverse	51,020	38,000
Ultimate	Longitudinal	78,600	68,400
	Transverse	77,200	66,400
Elongation	Longitudinal	Approx. 31.0%	37.5%
	Transverse	Approx. 31.0%	35.9%
Chemical Composition			
	Carbon	0.24%	0.24%
	Manganese	0.65	0.73
	Phosphorus	0.016	0.012
	Sulfur	0.019	0.029
	Silicon	0.20	0.19

* This pipe was A106 B material that had been quenched in water from 1650F and tempered at 1100F in order to raise the physicals.
† A106 Grade B pipe in the "as-received" condition.
‡ 0.2% offset.

TABLE 2—Strain Gage Location and Pipe Diameter Data

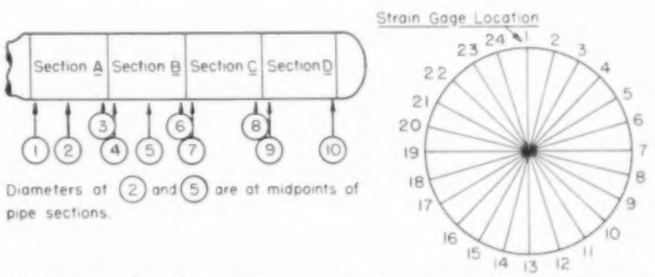
DIAMETERS

Axial Location → / Diameter	.500 Wall Pipe ②	1:16 Taper ⑫	1:8 Taper ⑥	1:4 Taper ⑤	.750 Wall Pipe ⑤
1–13	13.975	14.030	14.012	13.990	14.030
2–14	14.007	14.030	14.003	14.012	14.027
3–15	14.060	14.025	14.003	14.014	14.036
4–16	14.097	14.025	13.999	14.016	14.030
5–17	14.110	14.026	14.002	14.014	14.032
6–18	14.016	14.023	14.016	14.011	14.035
7–19	14.085	14.020	14.029	14.010	14.034
8–20	14.053	14.017	14.025	13.993	14.026
9–21	14.006	14.022	14.027	13.963	14.030
10–22	13.963	14.018	14.022	13.965	14.030
11–23	13.932	14.022	14.021	13.980	14.033
12–24	13.925	14.021	14.013	14.000	14.030
Average	14.027	14.023	14.014	13.997	14.031

THICKNESSES

Axial Location → / Circumferential Location	Section-A ①	Section-A ③	Section-B ④*	Section-B ⑥*	Section-C ⑦	Section-C ⑧	Section-D ⑨*	Section-D ⑩
1	0.514	0.489	0.745	0.750	0.498	.....	0.733	0.764
7	0.502	0.513	0.778	0.752	0.508	.....	0.753	0.750
13	0.509	0.528	0.768	0.762	0.516	.....	0.780	0.742
19	0.515	0.501	0.744	0.777	0.513	.....	0.756	0.759
Average	0.510	0.508	0.759	0.760	0.509	.....	0.756	0.754

* At end of taper, others at end of pipe.



Strain gage locations. Diameters at locations "2" and "5" are at midpoints of the pipe sections.

pipes were taper bored with specified slopes to end thicknesses of .500-inch. The four pieces of pipe were dimensionally inspected as shown in Table 2 and the minimum wall thicknesses in each pipe were marked so that they could be positioned on a common longitudinal line in the test specimen in order that ten pairs of SR-4, Type A8 strain gages could be mounted on a "minimum thickness line."

Details showing the welding and strain gage applications appear in Figure 1. Note that the longitudinal and circumferential strain gages were mounted both internally and externally at the mid-points of the three transition tapers and on one each of the .500-inch wall and .750-inch wall pipe sections.

Stress lacquer No. 1202 (initial cracking strain .00108 in/in.) was applied to one-third of the circumference over the entire length of the test assembly.

Test Procedure. Twelve equi-spaced diameter measurements were made at each of the five cross-sections where strain gages were mounted.

The assembly was filled with moisture-free transformer oil to prevent electrical leakage from the strain gages.

Internal pressure of 3000 psi was applied and pressure reduced to zero psi a total of seven times to ensure fully elastic behavior during the first part of the actual test.

In the test, internal pressure was raised in 500 psi steps to 3000 psi and from there on in 250 psi stages to 4250 psi. Strain gage readings and diameter measurements were made at each pressure step and at 3,000 / 2,000,/1,000 and zero psi pressures as the pressure was

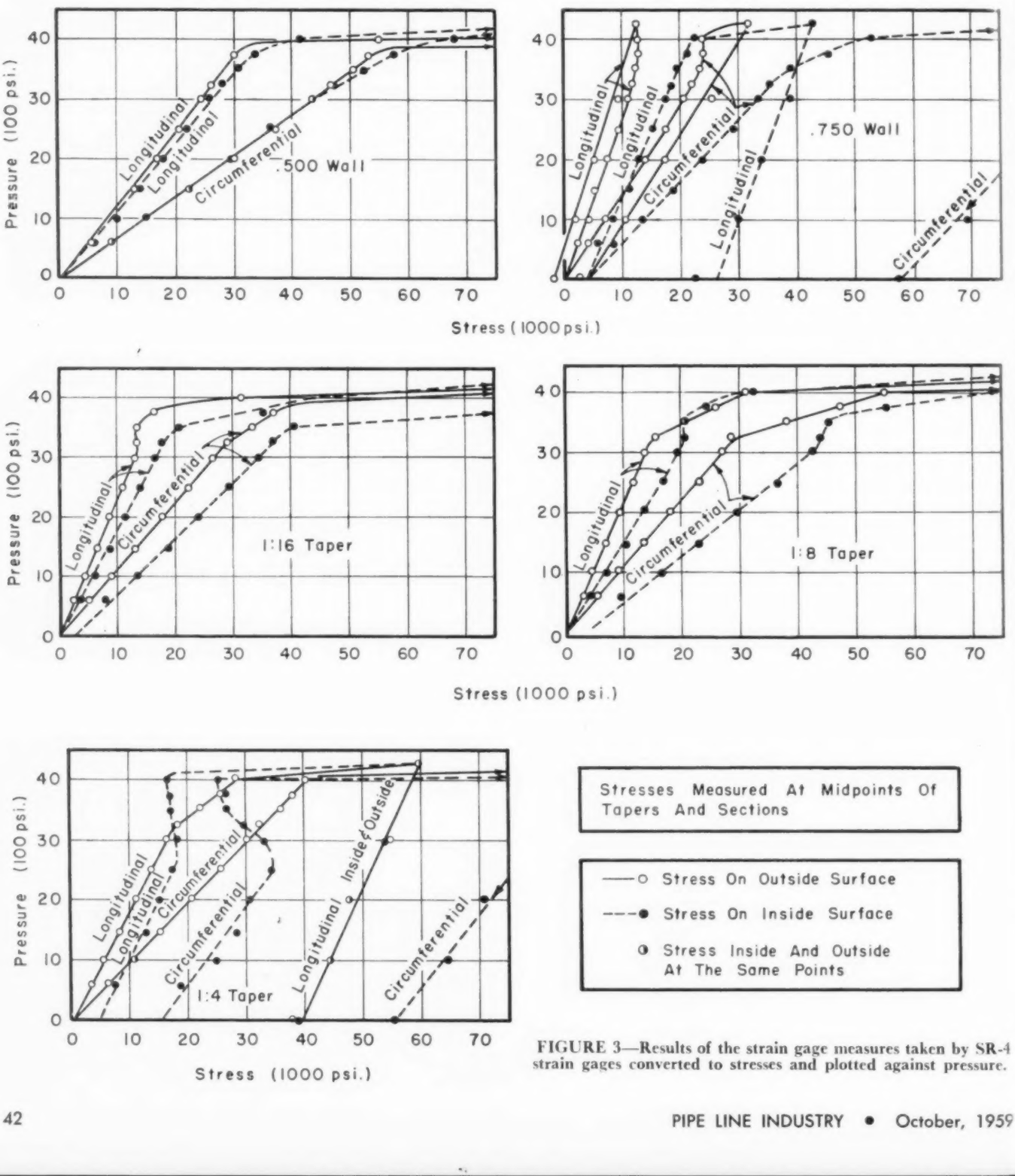


FIGURE 3—Results of the strain gage measures taken by SR-4 strain gages converted to stresses and plotted against pressure.

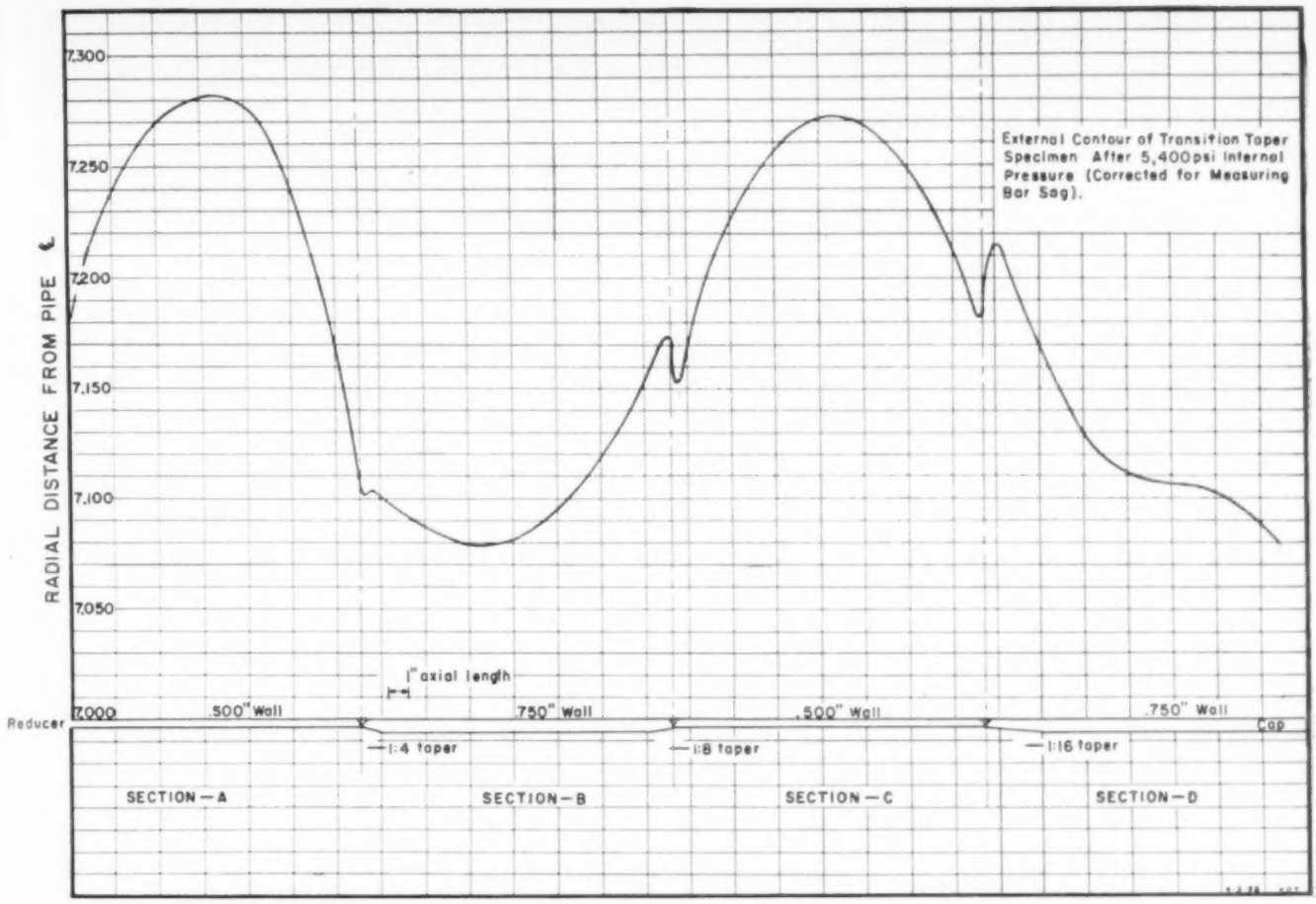


FIGURE 4—Radial deformation measurements made after specimen had been subjected to 5400 psi internal pressures.

released. The pressure was raised to 5,400 psi, held for five minutes and returned to zero psi. Radial deformation (contour) measurements were then made over the entire length of the specimen.

The transformer oil was replaced with water and internal pressure increased until failure occurred.

Test Results. The yield pressures for the different components of the test assembly, as indicated by a 0.2 percent offset by the various measurements, are summarized in Table 3.

TABLE 3—Summary of Yield Pressure Measurements

	YIELD PRESSURE, PSI, 0.2% OFFSET				
	Circumferential Strain Gage*		Diameter Expansion		
Midpoint of	Inside	Outside	In Plane†	90° to Plane†	Average
0.500" wall	4025	3975	3925	4025	3990
1:16 taper	3875	4000	4075	4025	3990
1:8 taper	4025	4050	4100	4100	4070
1:4 taper	~4300	4100	4225	~4300	~4230
0.750" wall	~4300	>4300	>4250	>4250	>4250

* None of the longitudinal strain gages reached 0.2% offset strain at 4250 psi.

† Diameters were in the plane or perpendicular to the plane of the strain gages.

~ Means about.
> Means greater than.

Stress lacquer cracks indicated a few areas of localized yielding in the 1:4 and 1:8 tapers when 3,000-psi pressure was applied for the first time. The localized nature of the stress lacquer pattern indicates that the cracking may have been due to local irregularities in the cross-sections or to ovality.

Stress patterns also appeared on the .500-inch wall pipe at a later pressurizing at 3,000 psi and on the .750-inch wall at 4,000 psi. With a modulus of elasticity of 30 million psi and an initial cracking strain for the stress lacquer of .00108 in/in., the cracking corresponded to 38,100 psi circumferential stress in the pipe. (Based on the relations between stress and strain in a biaxial stress field and on the assumption that the longitudinal stress is one-half the circumferential stress.) On an elastic behavior basis, stresses equal to the yield strengths of the materials would be reached at pressures of 4,030 psi in the .500-inch wall pipe and of 3,940 psi in the .750-inch wall pipe according to the principal stress theory.

Results of the diameter measurements made at the midpoints of the tapers and pipe sections are plotted in Figure 2 as change in diameter against pressure.

Results of the strain measurements by the SR-4 strain gages have been converted to stresses and are shown in Figure 3 as stresses plotted against pressure.

Radial deformation measurements after the specimen had been subjected to 5,400 psi internal pressure are shown in Figure 4.

In the hydrostatic burst test, the assembly failed at 5,825 psi pressure. The failure apparently originated in the center of .500-inch wall (high yield strength) section of pipe. From Figure 5a, it can be seen that the failure crack propagated into an adjacent section of the .750-inch wall (low yield strength) section in one direction, and in the other direction it stopped at the circumferential butt weld joining the pipe to a reducer.

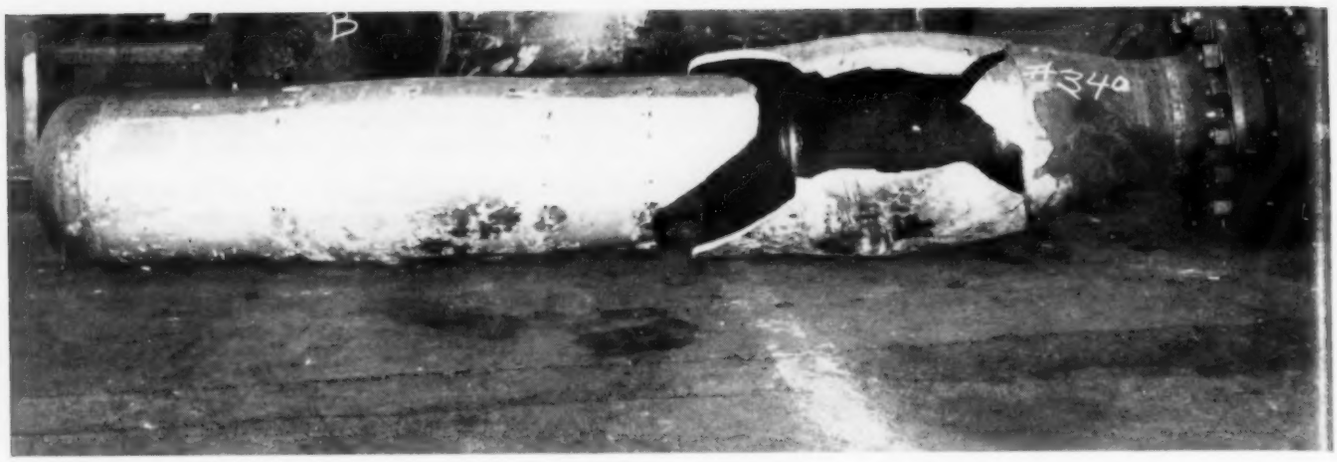


FIGURE 5A—Photograph of specimen after burst test. Failure came at 5,825 psi.

What Results Show. By calculation of stresses using a Modified Lame' type (Boardman) formula that does not take into account the possibility of a reinforcing effect stemming from adjacent heavier wall pipe, based on the transverse ultimate tensile strength of 67,400 psi for the thick wall material, the thin end of the taper would be expected to fail at 4,870 psi. In reality, it held at least 5,825 psi.

It is apparent, therefore, that the membrane stress calculation applied to tapered transition joints such as those tested have little significance insofar as predicting burst pressure. This is as expected for, in the plastic region, the adjacent thick wall pipe would be expected to support the thin end of the taper. It should also be pointed out that the taper end actually is weld metal with an ultimate tensile strength related to the weld rod material rather than to the pipe material.

Agreement between theoretical burst pressure of the pipe and the actual burst pressure is indicated in Table 4.

TABLE 4—Burst Pressure Comparisons

Section	Calculated Burst Pressure*	Ratio of Actual Burst Pressure to Calculated Burst Pressure
0.500" wall pipe	5680	1.026
0.750" wall pipe	7420	.785+
Small end of tapers	4870	1.195+

* $P = \frac{2St}{D-0.8t}$ where S = U.T.S. = 77,200 psig or 0.500" wall pipe and 66,200 psi for 0.750" wall pipe and taper; t = wall thickness; and D = outside diameter = 14".

+ = Did not fail.

A comparison of the experimental yield pressures with the calculated yield pressures (based on membrane stresses) is shown in Table 5.

TABLE 5—Comparison of Yield Pressures

Midpoint of	Calculated Yield Pressure y_c*	Ratio of Actual Yield to Calculated Yield y_A / y_c	Adjusted Ratio $\frac{y_A}{y_c} \times \frac{1}{1.060}$
0.500" wall	3750	1.060	1.000
1:16 taper	3520	1.133	1.069
1:8 taper	3520	1.156	1.091
1:4 taper	3520	~1.203	~1.135
0.750" wall	4250	>1.000	.....

* $y_s = \frac{2St}{D-0.8t}$ (Boardman formula) where S = yield strength of material. = 51,020 for 0.500" wall pipe. = 38,000 for tapers and .750" wall pipe. t = wall thickness (0.625" for midpoint of tapers). D = outside diameter, 14".

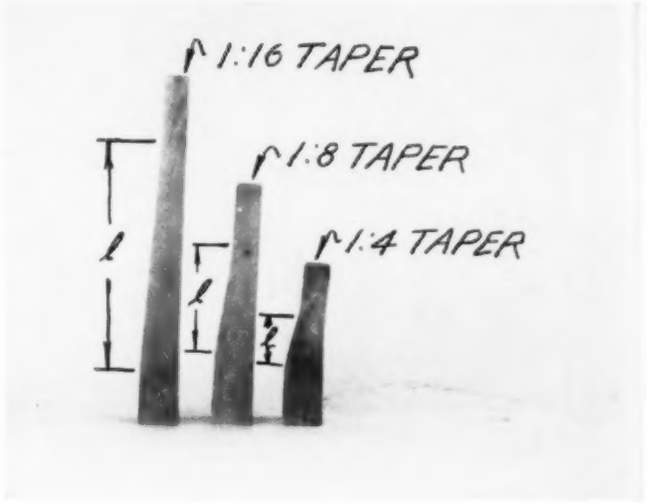


FIGURE 5B—Sections cut from the failed specimen showing tapers.

The righthand column in this table indicates that transition tapers yielded at pressures slightly higher than the pressures that would be calculated from the membrane stresses, and that the departure from agreement with membrane stresses increases as the taper angle increases.

The relationship between circumferential stress and internal pressure as determined in the elastic region with the SR-4 strain gages is summarized in Table 6 for each of the strain gage locations. Theoretical values for the straight pipe sections are also presented and compared

TABLE 6—Summary and Comparison of Measured Stresses with Calculated* Stresses

Direction at Midpoint of	OUTSIDE SURFACE Stress/Pressure Calc.	OUTSIDE SURFACE Stress/Pressure Meas.	OUTSIDE SURFACE Ratio Meas./Calc.	INSIDE SURFACE Stress/Pressure Calc.	INSIDE SURFACE Stress/Pressure Meas.	INSIDE SURFACE Ratio Meas./Calc.
Circumferential						
0.500" wall	12.52	14.3	1.14	13.52	14.3	1.06
1:16 taper	(9.72)	8.9	(.915)	(10.7)	10.8	(1.01)
1:8 taper	(9.72)	9.1	(.937	(10.7)	13.3	(1.24)
1:4 taper	(9.72)	10.1	(1.04)	(10.7)	8.4	(.785)
0.750" wall	7.86	6.9	.877	8.86	10.0	1.13
Longitudinal						
0.500" wall	6.26	8.0	1.28	6.26	8.4	1.34
1:16 taper	(4.86)	4.1	(.844)	(4.86)	5.3	(1.09)
1:8 taper	(4.86)	4.3	(.885)	(4.86)	6.7	(1.33)
1:4 taper	(4.86)	5.5	(1.13)	(4.86)	5.1	(1.05)
0.750" wall	3.93	3.6	.916	3.93	4.5	1.14

* The Lame' formula was used in the stress calculations.

with the measured values. Note that the stresses at the midpoints of the tapers fall between those for the .500-inch wall pipe and the .750-inch wall pipe. Theoretical values (membrane stress) for the .625-inch thick midpoints of the transition tapers are shown in parenthesis.

The calculated pressures shown in Table 6 above apply to circular pipe; however as noted previously, the pipe was slightly out-of-round and this would cause bending stresses. These extraneous bending stresses can be eliminated from the comparisons for the straight pipe sections by averaging the measured stresses at the inside and outside surfaces at a gage location because the bending stresses for the inside and outside surfaces are equal in magnitude but opposite in sign. Such an averaging process produces ratios of experimental to calculated stress as shown in Table 7.

TABLE 7—Comparison of Average Measured Stresses in Straight Pipe

	RATIO OF AVERAGE MEASURED TO AVERAGE CALCULATED STRESS	
	Circumferential	Longitudinal
.500" wall	1.10	1.31
.750" wall	1.00	1.03

Considering possible variations in the actual pipe wall thickness from the assumed nominal thicknesses of the .500-inch and .750-inch, the agreement between experimental and calculated stresses is satisfactory except for the longitudinal gages on the .500-inch wall pipe. These gages, for some unknown reason, showed stresses about 30 percent higher than would be expected from theory.

Taper Angle Effects. The contour measurements in Figure 4, taken showing plastic strains after 5,400 psi internal pressure reveal that the 1:4 transition taper produced a more abrupt change in general curvature than the 1:8 or 1:16 transition slopes. This was confirmed by section cuts made on the failed specimen. Photographs of cross sections of the tapers are shown in Figure 5b. It is also interesting to note that the strains in the tapers increase as the taper angle decreases, indicating that, if the taper angle were made smaller than those tested, eventually a taper would result in which the thicker pipe cannot support the thin end of the taper, even in the plastic region, and bursting could occur at a lower pressure, assuming that the ultimate strength (as well as yield strength) of the thick wall pipe is lower than that of the thin wall pipe.

Figure 4, also indicates that while the tapered sections may yield at lower pressures in the course of plastic straining, the taper sections are supported by the adjacent heavy wall sections and plastic strains become largest in the thin wall pipe where failure occurred.

Influence of Weld Metal. A rather pronounced dip over each weld can be noted in the radial displacement plot. These dips are traceable to the high yield strength and/or high strain-hardening rate of the weld metal. The reinforcing band effect of the weld metal is also evidenced in the pressure-longitudinal-stress plot.

It will be noted further that starting at about 3,000 to 3,750 psi, there is a reversal in direction of the longitudinal stresses inside the tapers, as would be expected when the tapers start to yield and the weld band does not yield.

Summary and Conclusions. Results of the testing program described herein indicate

1. The tapers had no apparent effect on the burst strength, failure occurring in the thin wall pipe at 5,825 psi or 1.026 times the burst pressure predicted by calculation with the Boardman formula.

2. The midpoints of the tapers yielded (.2 percent offset criterion) at pressures equal to or slightly more than the yield pressure of the .500-inch wall pipe. Accordingly, all tapers tested had adequate yield strengths.

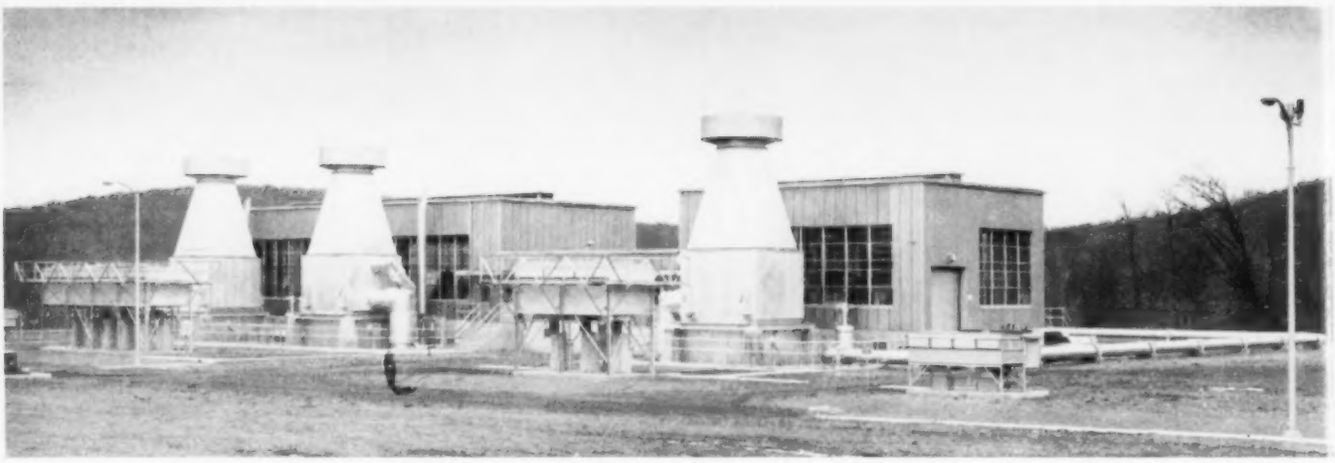
3. There is a bridging effect between members of metal structures whereby the stronger members tend to support the weaker members. In pipe line transition tapers between pipe of high yield thin wall pipe and low yield thicker wall pipe, the thin end of the taper is greatly supported by the adjacent thicker wall.

4. A study of the tests indicates that the best results were obtained with the 1:4 taper, which is the taper most frequently employed in making transitions. As the length of the taper increased or, stated another way, as the slope of the taper decreased from 1:4 through 1:8 to 1:16, rupture still occurred in the thin wall pipe at a point remote from the weld. However, the plastic deformation in the vicinity of the weld increased as the slope of the taper decreased from 1:4 to 1:16. From this it is concluded that the slope of transition tapers should not be smaller than 1:16 in order to insure the joint having a rupture strength equal to that of the thin wall being joined.

About the Authors

H. H. George, chief engineer, Product Engineering and Research Department for Tube Turns has long had an active professional interest in metal fatigue. His principal company responsibilities lie in the design of process and pipe line piping components. George graduated from the University of Pittsburgh with a B.S. degree in physics and engineering in 1935; he earned a M.S. in physics from Pittsburgh in 1939. His many articles on piping design and engineering, metal fatigue, and stress studies have been read with high interest throughout the pipe line and process industries.

E. C. Rodabaugh, principal research engineer at Tube Turns, has written several technical papers on industrial piping and its components. He received a B.S. in chemical engineering from Iowa State College in 1939; a master of mechanical engineering degree from the University of Louisville in 1959. Prior to joining Tube Turns, Rodabaugh became experienced as a power plant engineer and marine engineer. A member of ASME, he is active in several industry committees and cooperative research efforts.



How Does a Single-Shaft Gas Turbine

These machines have logged ten years operation on pipe lines. Here's a report on how they are doing and what lies ahead

By J. O. Stephens and L. O. Tomlinson
Westinghouse Electric Corporation, Philadelphia, Pa.

How FAR have gas turbines come and where are they going in the pipe line industry?

Just ten years ago they were experimental so far as pipe lines were concerned, and technical literature was carrying much of the promise offered by this new power plant. Today, the turbines are accepted prime movers—for gas, crude and products; and industry is in the process of increasing their power capability and improving their fuel efficiency.

There are several gas turbine configurations. The simplest—the single shaft machine—has been getting increased consideration and application in recent months. It has a number of advantages—both economic and engineering—which seemingly will make it the logical choice for many future installations.

Data compiled during the ten year operating history show both economic and operational advantages resulting from gas turbines in stations requiring 3,000 horsepower or more. The reliability of the gas turbine stations, including the more complex units, has equaled or exceeded that of the older prime movers.

Economic Characteristics. The characteristics of the gas turbine and the contributions of each toward economical operation are illustrated most conveniently by dividing the over-all station costs into three major components: (1) Installation, (2) Operating and (3) Maintenance.

Installation costs include the non-recurring costs such as the first cost of prime movers, compressors, auxiliary equipment, station piping, compressor building, office and auxiliary buildings, employe housing and land.

Operating costs are the sum of items such as fuel, lube oil, labor, and administration.

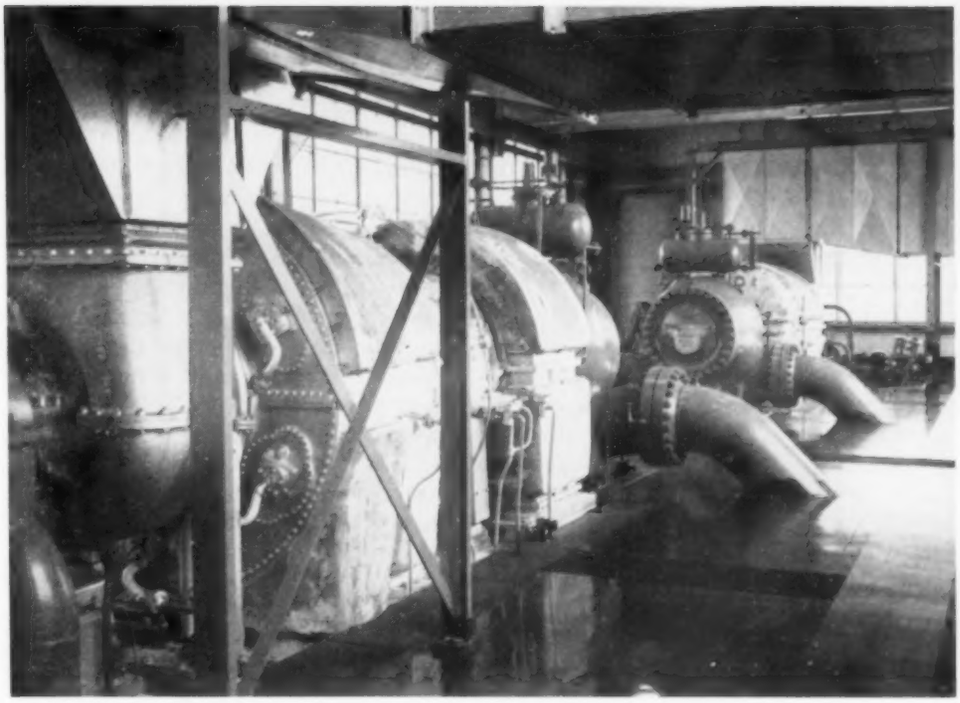
Maintenance costs include the cost of repair parts and labor for inspection and installation.

The greatest economic advantage afforded by the gas turbine is realized in the installation costs. Exact installation costs cannot be given because of the variation in cost of buildings and station sites. Also, the control system, which may be simple or complex in the case of a remotely operated station, varies with the policy of the operator. A typical non-regenerative 9,200 hp station (rated at 90° ambient temperature and 1,500-foot altitude) with metal buildings and a semi-automatic control system that may be operated with attendant type personnel can be installed for as low as $200 per horsepower. Lower costs can be realized with multiple unit or larger single unit stations.

Origin of these cost advantages are the light-weight, small size, and vibration free operation of the gas turbine and centrifugal compressor. Reduced building and foundation costs are results of these characteristics. For example, the weight of a 9,200-hp unit including compressor is 48,500 pounds; the over-all dimensions are 35 feet long, 9 feet wide, and 10.5 feet high. The small size and light weight of the component parts which must be lifted during disassembly and repairs eliminates the need of a high capacity crane which, in turn, eliminates the

FIGURE 1—Outside view (left), of a 15,000 hp gas turbine station. The minimum of auxiliaries gives the station a clean and neat appearance.

FIGURE 2—Inside view (right), of the station shown in Figure 1. Gas turbine, centrifugal compressor stations have proved highly successful over the past 10 years. The authors are predicting that 7,500 Btu's per horsepower-hour will soon be possible with single-shaft machines.



Stack Up?

need for heavy structural members in the building, etc.

A minimum of auxiliaries are required for a turbine station. This stems primarily from the low heat rejection to coolants. Heat is rejected only to the lubricating oil and exhaust. The former amounts to approximately one Btu per minute per horsepower. This amount of heat may be dissipated to the atmosphere with an oil to air radiator. *No water is required for station operation.* The lubricating oil system handles only four journal bearings, two thrust bearings, and the centrifugal compressor high-pressure gas seals. The electrical power for starting and operating a 9,200-hp station can be supplied by a 25 KW auxiliary generator in case of electrical power failure.

Another source of cost reduction is matching a centrifugal compressor with a turbine. Both are high-speed machines with similar rotative requirements. Thus, speed increasing or reducing gears are generally not required.

Economizers. Fuel is one of the important considerations in operating costs for high load factor stations. The best means of improving fuel rate is the addition of a regenerative heat exchanger. This expensive item may be justified where the load factor and fuel costs are high. However, an operator with a low load factor or low fuel cost (20 cents/million Btu and lower) can obtain the greatest advantage from the low installation cost of the simple cycle units without regenerative heat exchangers. These units are especially attractive for peak load applications; for base load regenerative units are preferable. Heat rates for modern gas turbines are approximately 9,000 Btu/hp-hr. for regenerative units and 12,800 Btu/hp-hr. for non-regenerative units.

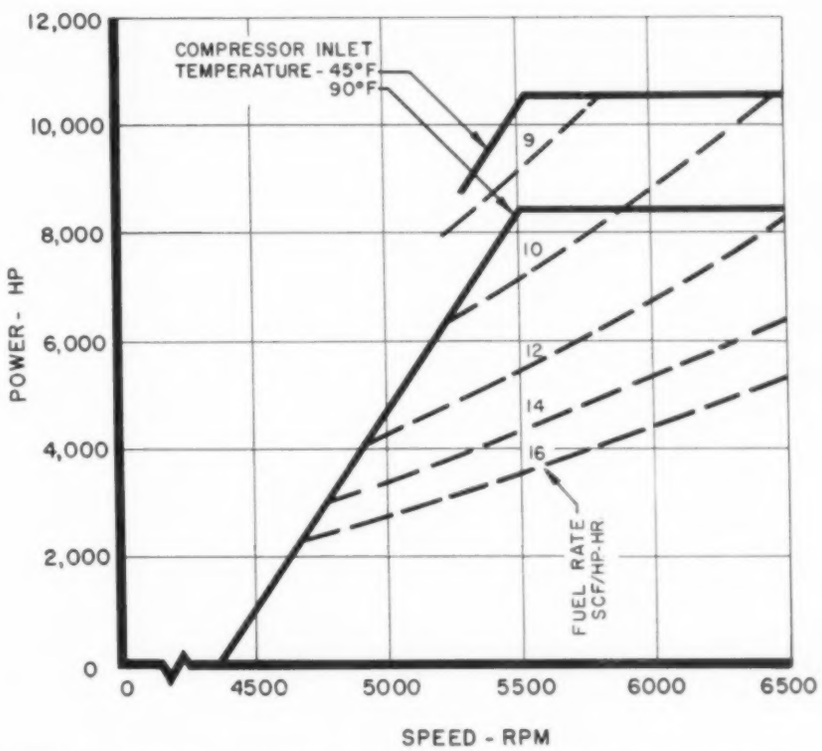


FIGURE 3—Single-shaft regenerative gas turbine power-speed characteristics vs. fuel rate. Operating conditions: Altitude—1500 ft.; Fuel—Natural gas; High heating value of fuel—1000 Btu's per standard cubic foot; Low heating value of fuel—900 Btu's per standard cubic foot.

Lubricating oil consumption has generally been negligible. Also, the

oil is not contaminated by products of combustion and changing oil is not necessary. Average annual lubricating oil costs have been 2½ cents per horsepower or less.

Labor costs for operation vary from a negligible sum for remotely operated stations to an average of $3.50 to $4 per horsepower per year. Of course, the cost will vary with each particular location and with individual operating policies. It should be pointed out that the ease of adapting the units to remote operations can greatly affect costs. There are no gas compressor pockets to adjust for decreased flow; manually filled lubricators have been eliminated; and the single rotating gas seal has fail-safe features. These features make it possible to operate attended stations with minimum personnel.

The cost of administrating any operation depends upon the amount of capital involved, the number and quality of personnel required for operation, and operational complexity. The gas turbine has materially reduced the personnel requirements and operational complexity, however, the primary contribution has been the reduction in capital because of the low installed cost. Costs associated with capital raising (such as interest and bond servicing) are thus reduced.

Maintenance costs for gas turbine installations have been exceptionally low. Records of repair parts supplied to operators of single shaft machines show an average annual repair parts cost of approximately $.80 per horsepower. This figure is based on actual repair costs over a 10-year period. Inspections and repair part installation costs vary with accounting procedures and maintenance policy of the operator, so exact costs are not available. An average cost is $2 per horsepower per year which adds up to an average annual maintenance cost of $2.80 per horsepower. These figures are based on early design units and as the new improved models go into service we can expect this cost to be further reduced.

Reliability is suggested by the low maintenance cost figures. Equipment reliability is of major importance on gas transmission pipe lines because the capacity of a line may be materially decreased due to inability to maintain line pressure if a station, or even one compressor unit, is not in operation.

Availability Factors. Prime movers are generally compared by the use of availability and reliability factors which are defined as:

$$\text{Percent Availability} = \frac{\text{Installed Hours} - (\text{Forced Outage} + \text{Maintenance}) \times 100}{\text{Installed Hours}}$$

$$\text{Percent Reliability} = \frac{\text{Installed Hours} - \text{Forced Outage Hours} \times 100}{\text{Installed Hours}}$$

Based on this method of total time measurement, single shaft machines in base load operation have compiled records of 97.4 percent availability and 99.5 percent reliability.

Operating Characteristics. The operating characteristics which point up the simplicity of loading and operation of the gas turbine driven centrifugal compressor are most conveniently illustrated by a series of curves. This series includes the operating characteristics of the gas turbine, compressor and pipe line and the composite station operation curve constructed from these components. The flexibility of operation which makes possible continuous line capacity build up by addition of compressor stations is also illustrated by the same series of curves. The series of curves compares an 8,400-hp station designed for base load and high fuel cost utilizing a single shaft, regenerative gas turbine with the 9,200-hp non-regenerative machine mentioned earlier.

The common method of illustrating the operating characteristics of a prime mover is the power-speed operating field. Figure 3 shows the operating characteristics of a typical single-shaft, regenerative, gas turbine, including efficiency lines.

The compressor converts the power and speed characteristics of the prime

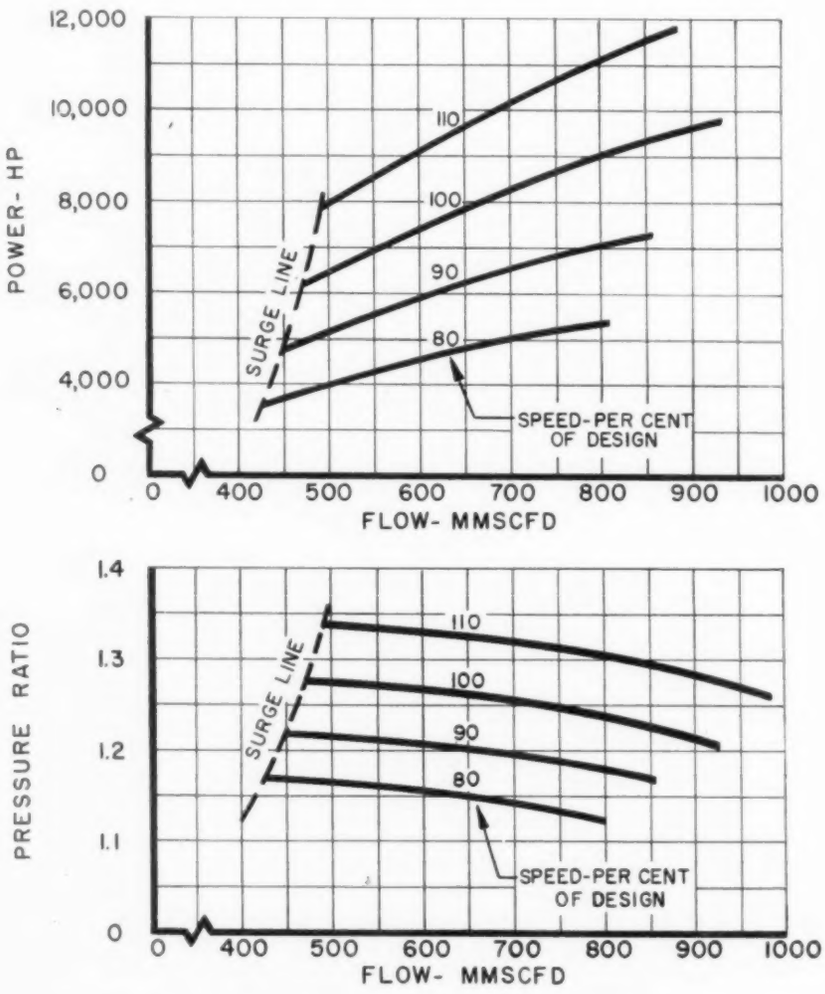


FIGURE 4—Centrifugal compressor performance characteristics. Discharge pressure is constant 925 psig. Design speed—6000 rpm.

mover to the familiar pressure-ratio flow characteristics of the pipe line. Typical pressure ratio, flow, speed and power characteristics of a centrifugal compressor are illustrated by Figure 4.

The pressure-ratio flow characteristics of the pipe line must be known in order to properly match the compressor and prime mover. Figure 5 shows the pressure-ratio flow characteristics of a typical pipe line. The two curves illustrate line capacity development by addition of compressor stations or part load operation of the completely developed line. The 90-mile spacing curve represents line characteristics for the first development step when half the stations are installed or part load operation of the completed line with alternate stations operating. The 45-mile spacing curve represents the line characteristics with all stations operating. These curves do not necessarily represent an actual line as many lateral connections are usually required which shifts the balance between stations. They do, however, serve to illustrate a typical case.

The compressor operation on the pipe line is illustrated by superimposing the pressure-ratio flow characteristics of the pipe line on the pressure-ratio flow characteristics of the compressor as illustrated by Figure 6. The speed range necessary to operate over a desired flow range is illustrated by this curve. The required power is derived by moving from an operating point on a constant speed line on the pressure-ratio flow field vertically along a constant flow line to the intersections of the same constant speed line on the power-flow field. For convenience, the pipe line operating lines are plotted in Figure 6 on the power-flow field.

The pipe line performance may now be depicted on the prime mover performance field because the power and speed requirements are known. The pipe line operating lines are superimposed on the gas turbine performance field in Figure 7, showing the flow range available from a single-shaft gas turbine-powered centrifugal compressor station by speed variation and by operating stations as required. Note that during all the operation illustrated above, the line discharge pressure was maintained at the design level which maintains line operating efficiency at its highest level.

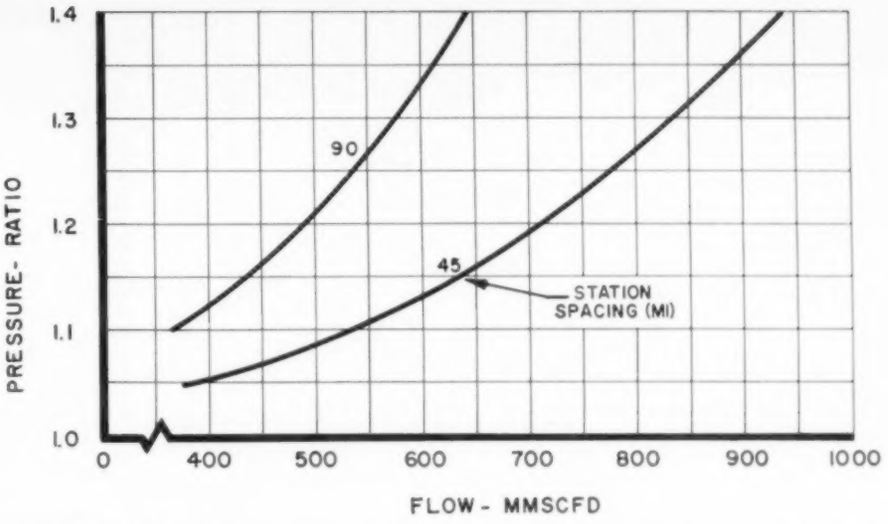


FIGURE 5—Pipe line pressure ratio-flow characteristics. In this instance the pipe is 30-inch O.D. with 3/8-inch wall thickness. Station discharge: 925 psig.

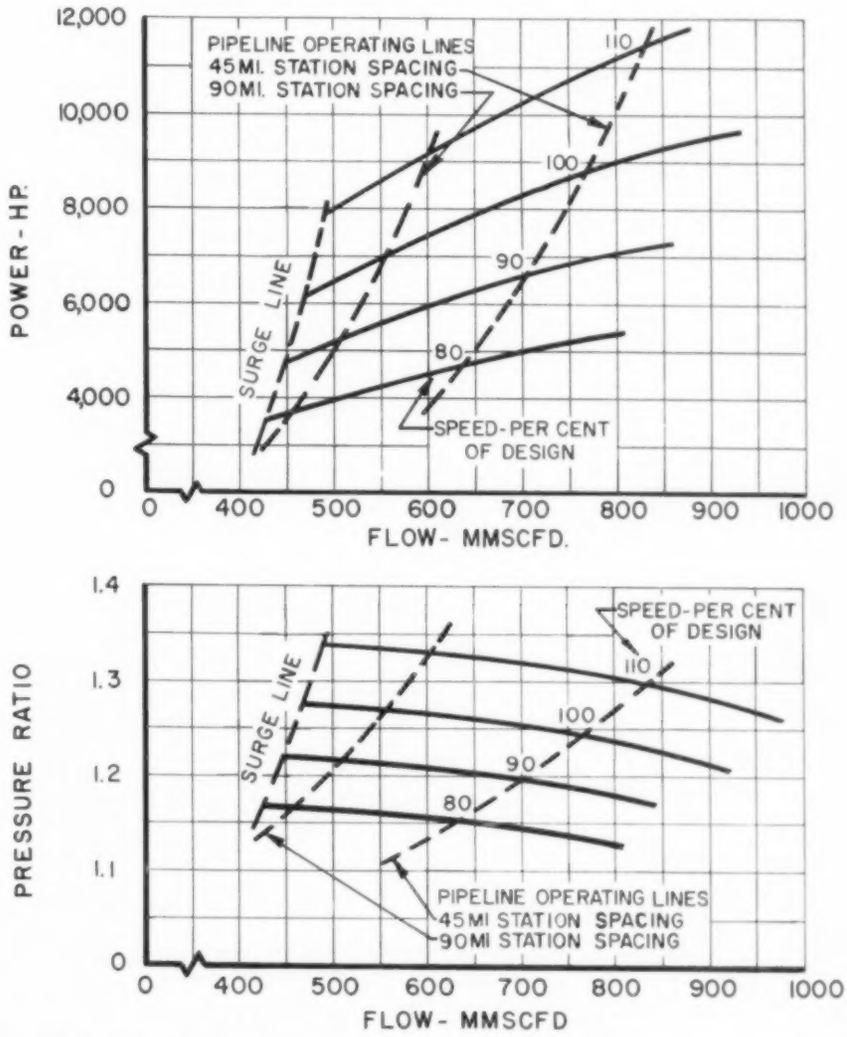


FIGURE 6—Combining Figures 4 and 5 matches centrifugal compressor performance characteristics with superimposed pipe line operating curves.

The part load efficiency of the gas turbine essentially equals the full load efficiency when driving a centrifugal compressor while operating the station at design discharge pressure. This point is illustrated by a comparison of the slope of the operating lines and the constant efficiency lines on Figure 7. The constant efficiency lines parallel the operating line so the effi-

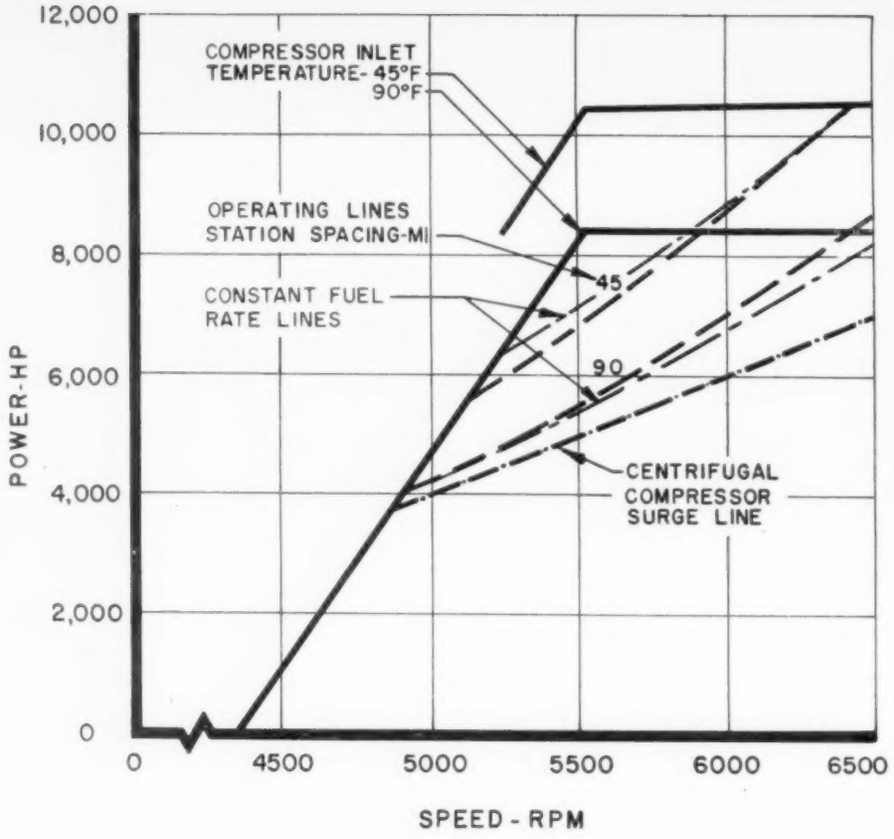


FIGURE 7—Single-shaft gas turbine, power-speed characteristics with pipe line operating curves superimposed.

ciency does not change as load is varied. This is an important consideration in favor of the single-shaft type of machine for gas line pumping.

Practical Factors. A simple series of curves cannot show the complete picture of a complex operation such as gas transmission. It does, however, serve to illustrate the field of operation at the most desirable operating condition; that is, at the pressure level for which the line was designed. The minimum flow of the line can be decreased further than the curves illustrate by a reduction in line operating pressure with no change in power required per unit of gas pumped. For instance, if the compressor speed is maintained constant and the line pressure is decreased to half the design level, the flow will be halved. Operating the compressor at the same speed maintains a constant pressure ratio and efficiency so the flow reduction reduces the power by one half. Thus, the power required per million cubic feet of gas is not changed.

The curves further illustrate that reduction in flow by speed reduction is limited by the centrifugal compressor surge line at design line pressure. Therefore, pressure reduction is necessary at low flow to keep the compressor in the stable operating region. As a result, the speed range of the single-shaft gas turbine is ample for the needs of most centrifugal compressors on gas transmission pipe lines and the extra cost of more complex configurations affording a greater speed range is generally not warranted.

An additional attractive operating characteristic of the gas turbine is its increased power capability during operation at low ambient temperature. This is especially important on lines supplying residential heating loads because extra power is available during cold weather when demand is greatest. The extra power is available for continuous operation, so a station located in a cold climate should be designed to utilize the extra power.

Future Development. In its present state of development the gas turbine is an economical prime mover for most installations in the gas transmission industry. Gas turbine manufacturers are now doing development work to decrease fuel rates and increase the power capabiljty of existing units.

About the Authors

Stephens

Tomlinson

James O. Stephens, manager of engineering-gas turbines, received a B.S. degree from Texas A&M College in 1935 and an M.S. degree from Purdue University in 1939. Before joining the Westinghouse Electric Corporation in 1945, he had worked with Allis-Chalmers Mfg. Co., Gulf Oil Corporation and served with the U.S. Army Ordnance. Stephens was project engineer on the first industrial gas turbine developed in the United States and has worked on subsequent developments of gas turbines.

Leroy O. Tomlinson is design engineer in the industrial gas turbine department at Westinghouse's South Philadelphia Works. He received a B.S. degree in mechanical engineering from Oklahoma State College in 1954 and joined Westinghouse that same year. His work has included thermodynamic design, development and production testing, performance analysis and field operation evaluation.

The most fertile development field is increased operating temperatures combined with higher regenerative effectiveness. Increasing temperatures of an existing unit 100° F. increases the power capability 20 percent and efficiency by 10 percent. It is expected that gas turbines with regenerative heat exchangers will be available in the near future with over-all plant heat rates of 7,500 Btu/hp-hr. (lower heating value) with the present trend in development of high temperature materials.

In conclusion, the acceptance of the gas turbine by the gas transmission industry during the first ten years of its operating history is evidence of its success in providing an economical and dependable power for gas transmission. Some gas lines have reported over-all operating costs 10 percent less than the best turbo-supercharged gas engines, and present development programs show promise of even more powerful and efficient machines in the near future. —**The End**

Rules of Thumb

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Engineering Design

—66—Determining Throat Pressure In Blow-Down System

In designing a gas blow-down system, it is necessary to find the throat pressure in a blow-off stack of a given size with a given flow at critical velocity. The accompanying nomograph is handy to use for preliminary calculations. It was derived from the equation:

$$P_t = \frac{W}{d^2} \times \frac{\sqrt{\frac{RT_1}{K\,(K-1)}}}{11{,}400}$$

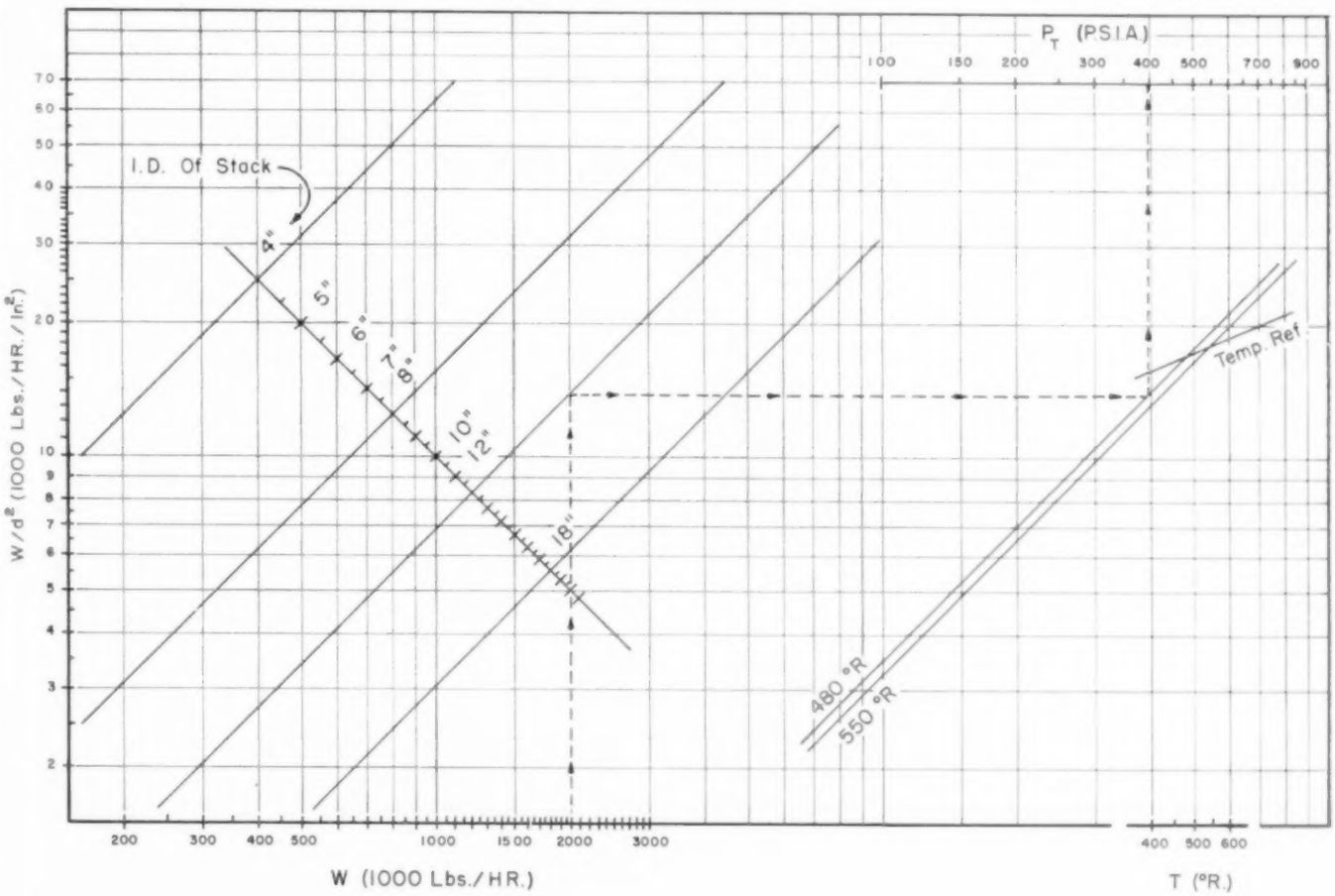
where:

P_t = pressure in the throat—psia
W = weight of flowing gas—lbs/hr.
d = actual I.D. of stack—inches
R = gas constant—ft lbs/°F
$K = \frac{C_p}{C_v}$
C_p = specific heat at constant pressure—Btu/lb/°F
C_v = specific heat at constant volume—Btu/lb/°F
T_1 = absolute temperature of gas flowing—
°R = (°F + 460)

Using the following values for natural gas
R = 88.888 and K = 1.31 the above equation reduces to:

$$P_t = \frac{W}{d^2} \times .0012978 \sqrt{T_1}$$

Example: To use the accompanying nomograph, assume that the rate of flow is known to be 2.00×10^6 lbs/hr., the I.D. of the stack is 12 inches and the flowing temperature is 480° R. Start from the abscissa at the Rate of Flow, W, and proceed upward to the I. D. of the pipe. From this intersection proceed to the right to the flowing temperature of 480° R. Turn upward from this intersection to the P_t scale and read the answer—395 psia.



Pipe Line Pete's

IDEAS FOR THE FUTURE!

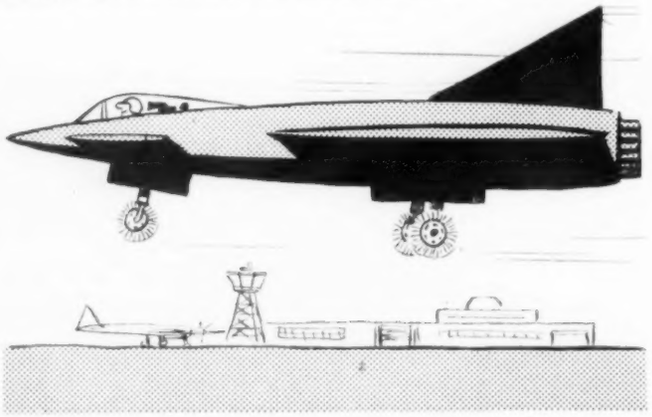
. . . in pipe line engineering, construction and operations

Built-in Insect Repellant

Why not apply an insect repellant to a garment being manufactured so that it will last the life of the garment? This would do away with frequent application of repellants, and give continuous protection against many species of insects. Present methods for testing chemicals for possible repellant action are costly, tedious and relatively inaccurate. New methods must be developed to overcome these handicaps, says the National Inventors Council of the U.S. Department of Commerce. Among those who will benefit particularly are military personnel in operational areas where the nuisance character of insects cuts down on efficiency and comfort.

Rubberless Tire Developed; New Material Announced

Paradoxical as it seems, Goodyear Tire and Rubber has developed a completely rubber-less tire! The tire, containing neither rubber nor fabric, is made of wire. It was



designed especially for use as a landing wheel and tire for space vehicles which pass through the thermal barrer on re-entering the air mass. Goodyear says the tire will withstand temperatures in the 1000° to 2000° F range.

Paving material from coal. Curtiss-Wright has developed a paving material from coal which it claims is more resistant to skids than asphalt and will support 30 percent more weight.

Coastal plants to convert sea-water to fresh. A number of experimental plants are scheduled to be constructed in the near future. The purpose—to find an economical way to make fresh water from sea or brackish water.

Meanwhile, Southern California Edison has awarded a $100,000 contract to Cleaver Brooks Special Products, Inc. to construct a 100,000-gallon-per-day plant at Oxnard, Calif., this summer. The method will be to flash evaporate water in vacuum chambers at temperatures below the normal boiling point.

When an economical method of converting sea water to fresh water has been developed, there will be little trouble in finding a way to move it inland. Pipeliners have already taken care of that.

Keep Your Pipe Line—Nuclear Power Not Taking Over Yet!

Whew!

Us pipeliners got a severe jolt the other day. The newspapers carried a story on how nuclear scientists are now producing electricity directly from atomic energy. A device the size of an ordinary beer can produced enough electricity to burn a light globe 12 hours, and presumably had scads of juice left over.

Now in this day and time, I'm not one to doubt one of these *S-c-i-e-n-c-e M-a-r-c-h-e-s O-n* type stories. We've got machines that translate foreign languages into faultless English, and rockets that wish everyone Merry Christmas, and all—so when I read about the beer-can-sized atomic energy package in *The Wall Street Journal* and a few other newspapers, I called a broker to sell my Tennessee Gas and Transco stock.

After all, if nuclear gadgets are going to take over, who needs big gas pipe lines? Besides it would be a dandy time to buy stock in the atomic energy device. (Trouble was, it belonged to the government. Seems the government is moving quite a bit into owning or controlling *power*. But I'm sure this must be for our own good.)

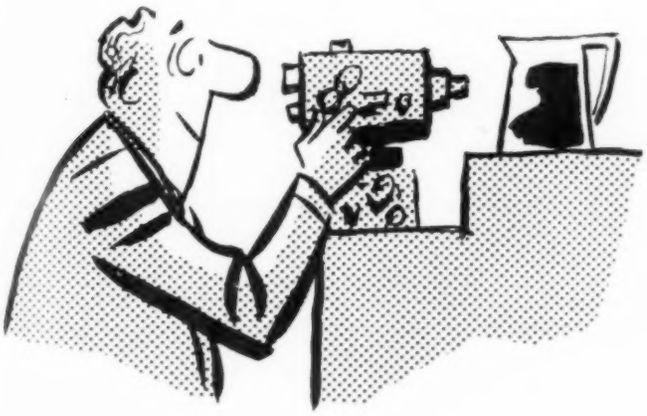
In any event, I decided to find out just how this gadget worked and when I could buy a six-pack, so to speak, for my house.

Basically, the new device works on the thermocouple principle described on page 62 in the March issue of PIPE LINE INDUSTRY. Only in this instance, ionized cesium gas plays the part of the juncture between two dissimilar metals.

A small rod of uranium measuring ¼ by ¾ inches is mounted in a small copper can filled with the cesium gas. When this device was lowered into a Los Alamos reactor, the uranium fissioned, giving off heat. Electrons will flow through the cesium gas collecting on the relatively cool copper can. Wires completed the circuit.

But the device is a long way from commercial application. Very few people have reactors these days anyway. So it looks like the gas companies should keep their pipe lines—for the time being at least.

Spectrographic Methods to Check Engine Wear



Detection of metals in lubricating oils by spectrographic methods provides a simple means of judging engine wear and at the same time serves as a guide for engine maintenance. Under the sponsorship of the API, the National Bureau of Standards is developing a series of oil-soluble metal analytical standards. About 175 compounds were selected for use as standards for the determination of 23 elements.

Non-Lubricated Bearings

They are made of a teflon and cotton fabric immersed in a solution of phenolic resin, dried at a temperature of about 180° then formed under pressures ranging from 15,000 to 20,000 psi.

The resulting bearing has a low coefficient of friction, needs no lubrication and resists most chemical attacks.

Does Gas Always Cool As it Expands?

It depends on the pressure. For example, natural gas wells in a South Louisiana field have a shut-in pressure of about 9,400 psig. As the gas flows through the chokes to expand to a pressure of about 6,000 psig, it actually increases its temperature. Explanation is that the heat from internal friction exceeds the cooling effect. In this case, the gas coming out of the well has a temperature of about 80° F, and any expansion short of 2,700 psi will cause a temperature rise.

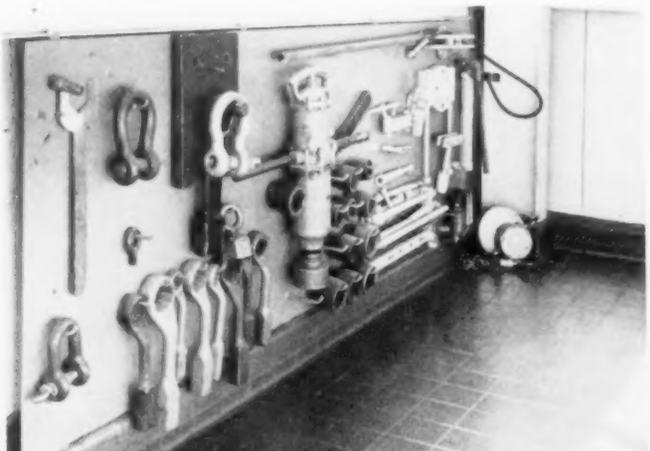
Turbines Used Abroad

A gas-fired turbine that develops 40,000 horsepower has been operating in Beznau, Switzerland, since January, 1949, and three 33,000-hp turbines have been operating in Italy for some time. Thermal efficiency of these units runs about 28 percent. These giant horsepower packages were manufactured in Switzerland, which may be considered the birthplace of modern gas-fired turbines. One gas-turbine, rated at 5,000 hp, has been operating in Switzerland since March, 1940.

How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas



Heavy Board Bolted to Wall Makes Tool Rack in Station

Heavy equipment is needed to overhaul a compressor or engine at a pipe line compressor station. To reduce the labor of moving such tools from the shop to the compressor building, attendants at a southeastern station erected a heavy-duty wooden board bolted to the building frame to store all necessary tools.

As shown in the photograph, all essential tools are easy to spot and easily accessible to attendants. The heavy impact wrench (center), is used in dismantling compressor and hydraulic pump on far right, is used in pulling impeller out of centrifugal unit.

Use Identification Signs For Lines in Headers System

Complex as some of our manifolds are these days, its a wonder the gas, oil or products going through them doesn't get lost. Moreover, with every tank switching, change in tender etc., the flow arrangement is different.

Here is a neat solution devised by one of our leading products pipe line companies. By welding vertical dowels or pegs some 10 inches apart on all the manifold lines, clip-on identification signs can be added, or changed at will. The ends of the signs of course are curled to fit the pegs.

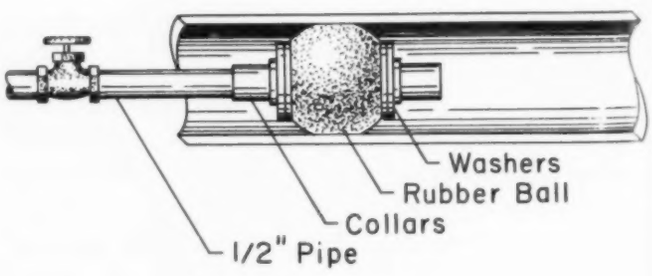
Make Efficient Pack-Off Gland From a Rubber Ball

You may find an occasion when this idea will pay off like three bars on a slot machine. From an ordinary rubber ball—the kind you buy at a toy shop—you can make a highly efficient pack-off for small diameter lines.

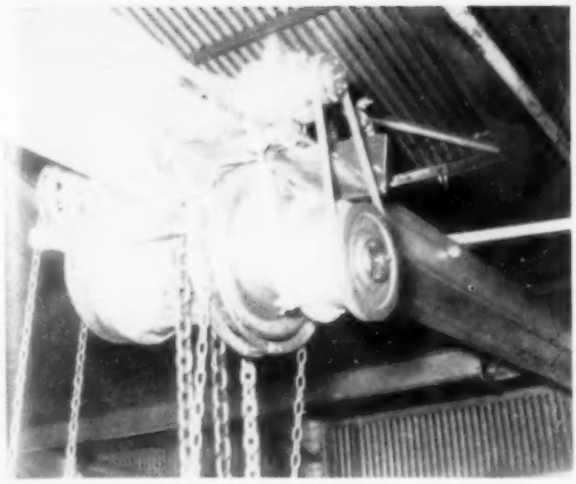
Here's the way you do it. First machine the ball to the approximate diameter of the pipe. Drill a hole through it to fit a half-inch pipe or bolt. Insert the pipe (or bolt) through the hole in the ball and place washers above and below the ball so it can be squeezed.

Tighten the collars (or bolt) and the ball expands against the inside of the pipe. If the ball can be machined to a concave shape it will be more-or-less self-sealing.

The danger of this arrangement lies in its efficiency.



Care should be taken to insure that there is no pressure behind the rubber ball before it is removed; otherwise, it may be propelled from the pipe like a bullet.

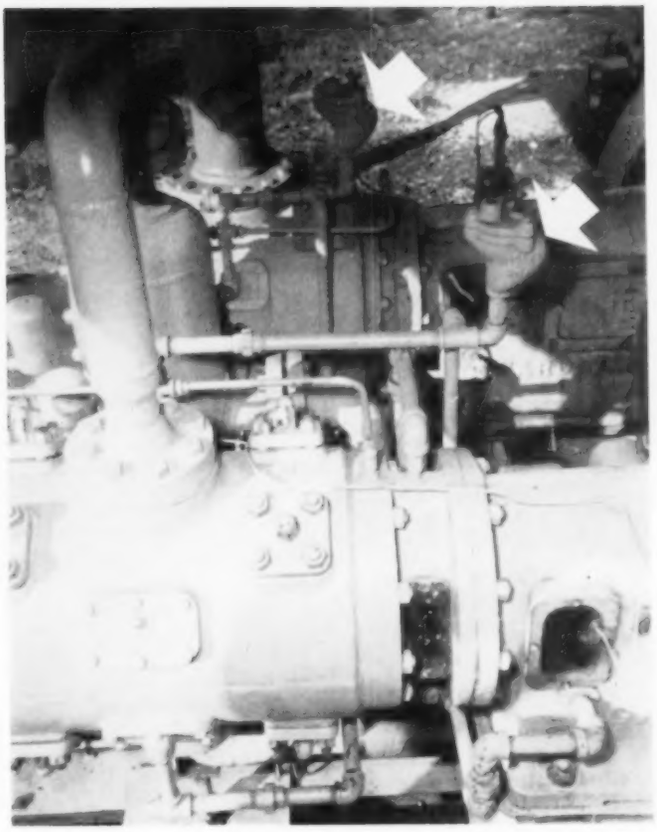


Chain Hoist Is Easily Converted to Air Hoist

Your present chain hoist can be converted to an air hoist for one-forth the price of conventional air hoist. An adaptor can easily be made to bolt to the chain wheel for mounting a speed reducer. The speed reducer is belt driven by a 2 hp reversible air motor operated with a 4-way valve.

Another advantage, besides being cheaper, is that in case something goes wrong with the air motor, speed reducer, air hose or air supply, the hand chain can be put back on chain wheel, belt removed, and chain hoist used as before. With belt removed the speed reducer causes very little drag on the hand chain pull.

The picture shows such an installation on a 2-ton chain block before hand chain was removed from chain wheel and before small pull chains were installed to operate 4-way valve. The installation pictured was used during complete overhaul of six 10-cylinder engines and its performance was equal if not better than conventional 2-ton air hoist. Another feature is more head room as compared with the conventional.



Steam Traps Remove Air From Cooling Water System

Entrained air in a cooling water system will cause cavitation, shortening the life of the pump impellers, heat exchangers, etc. There is an inexpensive solution to this problem. Simply attach a steam trap to the highest point in the system. Of course, the traps must be the kind that can be piped for steam or for vapor.

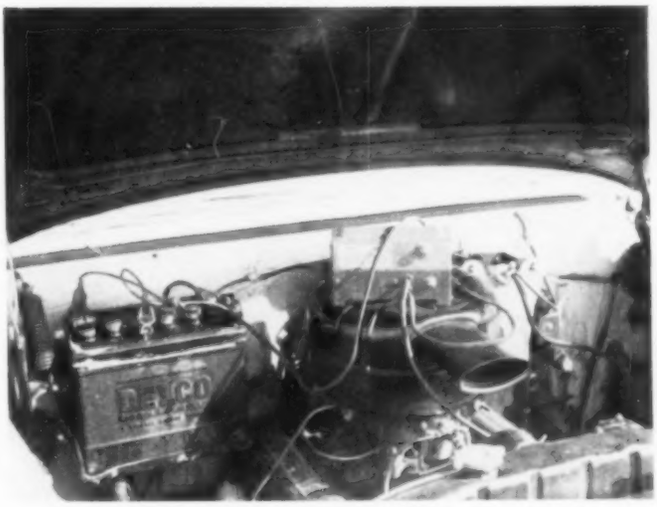
The cost of this installation is insignificant when compared with possible cavitation damage.

Convert 6-Volt Chargers for Use on 12-Volt Batteries

If you're equipped with a 6-volt battery charger but have 12-volt batteries in your cars or trucks, here are some tricky ways to get a full charge when it is necessary to boost your battery.

For a long overnight charge, convert the 12-volt battery into two 6-volt sections charging one at a time. Simply punch a hole in the center pitch to expose the lead tie strap in which a lead hole is drilled to take a cadmium plated sheet metal screw for the center tap connection. Then charge each section separately.

In an urgent case where the vehicle is needed immediately, a hot shot charge can be applied with two chargers, using each to one half of the battery simultaneously. For boosting batteries in the garage, the 6-volt chargers can be connected in series for 12 volts. With this arrangement, either 6- or 12-volt batteries can be charged.



WHAT'S HAPPENING

IN PIPE LINE CONSTRUCTION

By Donald G. DePugh, Construction Editor

Helicopters Used to Apply Concrete Weights In Swampy Terrain

Employing a new technique during construction in swamps in Minnesota, Northern Natural Gas Company called on helicopters to apply concrete weights to the pipe line in the ditch. Some 2,700 weights are being used by Pipeline Welding and Construction Company on the 60-mile stretch between Farmington and Elk River, Minn. The helicopter picks up the 3,000-pound weights and ferries them to the line. At right, the "copter" hovers over the line while workmen guide the weight on the pipe. This is part of Northern Natural's $114 million construction program for 1959-60.

Coal Slurry Pipe Line Considered By Texas Eastern Transmission Corp.

Construction of a coal slurry pipe line is being considered by Texas Eastern Transmission Corporation and several eastern utility companies.

The project would consist of a 350-mile, 24-inch pipe line from Western Pennsylvania and West Virginia coal fields to New York and Pennsylvania area. The idea is still in the talking stage as companies are making feasibility studies. Interested companies in addition to Texas Eastern include Consolidation Coal Company of Pittsburgh; Consolidated Edison Company of New York; Public Service Electric and Gas Company of New Jersey; Pennsylvania Power and Light Company of Allentown, Pa.; and Philadelphia Electric Company.

Consolidation Coal Company, which would supply the coal, presently operates a 135-mile 10-inch coal line from Cadiz, Ohio, to Cleveland. Texas Eastern will build and operate the line if the project materializes.

Although the route of the line has not been determined, it could be laid on Texas Eastern's right of way from Oakford Storage Basin in Western Pennsylvania.

Should Texas Eastern build the line, it will have the distinction of carrying solids, liquids and gas through its pipe lines. The transmission company moves natural gas through its big-inch lines to the east and transports products through its "Little Big Inch" line to the Midwest and East.

Columbia Gulf Will Use Jet-Turbine Prime Mover

Columbia Gulf Transmission Company has announced plans to install a jet-powered gas turbine engine driving a centrifugal compressor.

The gas transmission company has filed an application with the Federal Power Commission for approval to construct the new type prime mover at its Clementsville, Ky., station.

The new concept for station design will incorporate a modified J-57 jet engine using natural gas as its fuel. The J-57 is used in the Boeing 707 and Douglas DC-8 jet airplanes.

Engine Design. An additional power turbine will be connected to the jet-turbine to absorb its power and drive the compressor. Differing from present pipe line gas turbines, the modified jet-turbine will not need a regenerator.

Several features of the new turbine include its compactness, maintenance, operation efficiency, initial cost and construction cost. The 10,500-hp engine weighs only 4,000 pounds. As the small unit is easily installed and replaced, during overhaul the turbine can be removed from the compressor and a temporary unit installed in a few hours to put the station back on the line. The station will be designed for unattended operation; construction is expected to begin this fall.

Harbert Construction Co. Gets Southern Natural Work

Southern Natural Gas Company has awarded a contract to Harbert Construction Corporation for construction of 22 miles of 20-inch and 22 miles of 14-inch gas pipe lines.

FPC Authorizes Several Gas Pipe Line Projects

Columbia Gulf Transmission Company has received temporary FPC authorization to construct 41 miles of 24-inch loops to cost $3.9 million. The loop will extend from Erath Junction in Vermillion Parish, La., along its east lateral to a junction with its 12-inch Lake Sand gathering line in St. Mary Parish, La.

United Fuel Gas Company was authorized to build 5 miles, 16-inch gas line and install 8,400 horsepower capacity on its system near Huntington, W. Va. Facilities are estimated to cost about $3.5 million.

The FPC also granted United Gas Pipe Line Company permission to construct about 9 miles of 30-inch paralleling a section of its system which will be submerged by a flood control project on the Angelina River in Texas. The $2.2 million line parallels part of United Gas' existing line which extends from the Agua Dulce field in Texas to Sterlington, La.

The Ohio Fuel Gas Company was issued a certificate for pipe line facilities to provide more effective utilization of the company's Pavonia County, Ohio.

Project includes 6.4 miles of 24-inch line in Licking County, Ohio, and 1,500 hp at Pavonia compressor station. Cost is $865,000.

Right of Way Procedures For Outer Continental Shelf

The Department of the Interior has proposed an amendment concerning the outer continental shelf right-of-way procedures for oil and gas pipe lines. New regulations would permit granting of new rights-of-way across existing rights-of-way without permission of the holders.

The applicant for a new right-of-way would still have to notify holders of existing rights-of-way that would be affected, but he would no longer have to gain their permission. If Bureau of Land Management granted the application, holders of affected rights-of-way could appeal the decision. Complete text of proposed regulations will appear in the Federal Register. Anyone may submit comments or suggestions for a 30-day period to the Director, Bureau of Land Management, Washington 25, D.C.

Automatic Welding Machine Speeds Aluminum Line Work

Lavaca Pipe Line Company completed a 4,500-foot, 8-inch aluminum gas gathering line at its Point Comfort, Texas gathering system. Automatic welding (above) was used to speed construction work. Wall thickness of seamless pipe was 0.204-inch along the length and 0.322-inch at the joint ends. The line was buried without coating and wrapping and will carry gas at a pressure of 500 psi.

Transwestern Given Approval To Construct 1,800-Mile System

Transwestern Pipeline Company has been authorized to start construction on its Texas-California, 1,800-mile gas system. The Federal Power Commission amended its original decision authorizing the company to build the line, subject to producers acceptance of the FPC certificate. Producers are requesting that the FPC allow their original contract prices to sell gas to Transwestern. August 10, the FPC had ordered the producers to cut their prices from 1 to 6 cents per MMcf. A prehearing conference for the producers will be held October 27.

Gulf Oil Corporation, which will supply over one-half of the gas to be sold by Producers to Transwestern, announced it will accept the certificate issued by the FPC authorizing Gulf to sell to Transwestern.

Alberta Gas Trunk Line Plans 386-Mile Gas Line

Alberta Gas Trunk Line Company will build the first leg of a 1,300-mile gas line from Alberta, Canada, to California. Alberta plans a 386-mile, 26-36-inch main line from Berland River field, in Northwestern Alberta, to Alberta-British Columbia border. Alberta also will construct about 235 miles of 8-to-18-inch gathering lines to gas fields in Alberta. The Foothills project will cost approximately $100 million.

Alberta Natural Gas Company will build a $40 million, 110-mile, 36-inch segment from the Alberta-British Columbia border to Kingsgate, B.C., at the Idaho border. Alberta Natural is owned by Westcoast Transmission Co. and Alberta & Southern Gas Co.

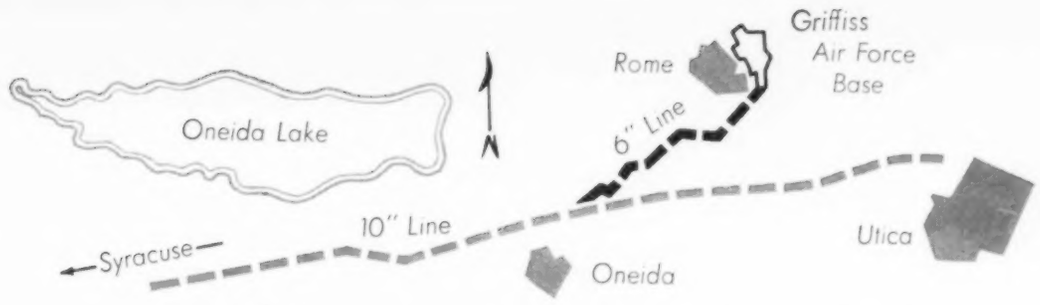
The FPC hearing on Pacific Gas Transmission Company's 614 mile, 36-inch line from Kingsgate to California will start October 15. Pacific Gas & Electric Company plans to lay the final 296-mile, 36-inch section from Oregon-California border at Klamath Falls, Ore., to San Francisco. Total cost of the project is about $330 million.

United Gas Pipe Line Co. Completes Gathering Lines

United Gas Pipe Line Company has completed construction on its 24 miles of 8-12-inch gas lines in the Galveston Bay area in Texas.

The lines tie in with United Gas Houston to Orange, Texas, main line.

Jet fuel line goes in despite snow...



v....ice...frost...and mud

EARLY THIS YEAR, Buckeye Pipe Line Company installed the 11-mile spur line which now supplies Griffiss Air Force Base with jet fuel. Built with Bethlehem 6-inch electric resistance-weld pipe, the spur takes off Buckeye's 10-inch Syracuse-Utica products line at Verona, N. Y., and ends at the Air Base just outside Rome, N. Y.

Because of the urgency of the project, the contractor, Sheehan Pipe Line Construction Company, laid a good part of the line on top of the frozen ground. It was buried later when the first thaw permitted ditching. And to save even more time, the entire 11 miles was tested with product instead of water. In spite of the weather, the line went in smoothly—thanks in large measure to the top-quality of Bethlehem pipe.

Our engineers will be glad to assist you in any way possible. Just get in touch with the nearest Bethlehem Steel sales office.

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NEED LINE PIPE? *Bethlehem makes hydraulically expanded electric fusion-weld pipe from 18 in. through 42 in. OD with walls to $\frac{3}{4}$ in. in all diameters, and in 40-ft lengths; electric resistance-weld pipe from 5 in. (nom.) to 16 in. OD, in lengths to 60 ft; and continuous buttweld pipe $\frac{1}{2}$ in. to 4 in. (nom.) in various lengths. Bethlehem line pipe meets the appropriate API specifications.*

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BETHLEHEM STEEL

PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

U. S.

Alaska Juneau Gold Mining Co., Los Angeles, 425 miles, 16-inch, gas, Oklahoma City area to St. Louis, planned.

Arkansas Industrial Pipeline Corp., Shreveport, 130 miles, 18-inch, gas, Perla-to-Helena, Ark., $9 million, planned.

Atlantic Seaboard Corp., Charleston, W. Va., 26-miles, 26 and 20-inch, gas, in West Virginia, Virginia and Maryland, contract let on 19 miles to H. L. Gentry Construction Co.

Carolina Pipeline Co., gas, main line, from near Aiken to Pontiac, S. C., $5 million, approved.

Coastal States Gas Producing Co., Corpus Christi, Texas, 289 miles, 14 and 18-inch main line and gathering system, McAllen to Falfurrias, Tex., area, and Lopena to La Salle County, $12 million, contract let on 200 miles to O. R. Burden Construction Corp.

60 miles, small diameter, gas gathering line, to tie in with system under construction and extend to Pearsall County, Texas, planned.

25 miles, gas, Associated Gas & Oil Co. field to South-Tex Corp., processing plant west of Corpus Christi, Texas, planned.

37 miles, gas gathering in Brown, Eastland, Comanche and Erath counties, Texas, planned.

Coastal Transmission Corp., Houston, compressor station additions and new lateral lines, $6.2 million, before FPC.

Colorado Interstate Gas Co., Colorado Springs, 140 miles, gas, Green River, Wyo.-to-Provo, Utah; 109 miles, 26-inch, Texas Panhandle to southeastern Colorado; 136 miles, 34-inch, southeastern Colorado-to-Pueblo, Colo.; 107 miles, 30-inch, Pueblo-to-Denver, $91 million, before FPC.

Colorado Oil & Gas Corp., Denver, 400-miles, gas, from Gubik field to Fairbanks, Alaska, planned.

Columbia Gulf Transmission Co., Houston, 12.8 miles, 6 and 20-inch, gas, loop line in Louisiana, $730,000, authorized.

41 miles, 24-inch, gas, loops, Lake Sand Junction to Arath Junction, La., FPC temporary authorization.

East Coast Pipeline Co., 90 miles, 12- to 24-inch, products, Linden, N. J. to Suffolk County, N. Y., $25 million, planned.

El Paso Natural Gas Company, El Paso, 244 miles, 30-inch, Permian-San Juan loops, 108 miles, 20-inch, field feeder lines, before FPC.

69,240 hp in new and existing stations in Texas, Oklahoma, New Mexico and Utah, planned.

400 miles, 34-inch, Salt Lake City, Utah, to California border, before FPC.

Equitable Gas Company, Pittsburgh, Penn., 11.7 miles of storage pipe line and other facilities, $2,091,430, authorized.

12½-miles, 16-inch, paralleling existing system in Harrison and Marion counties, W. Va., authorized.

Florida Pipeline & Storage Co., 54 miles, products, Port Everglades to Homestead Air Force Base, Fla., planned.

Gillette Pipeline Co., Cheyenne, Wyo., 103 miles, crude, from Dead Horse Creek field to Casper, Wyo., planned.

Great Northern Railway, St. Paul, 400-600 miles, 12-20 inch, crude, from Williston Basin to St. Paul-Minneapolis and Duluth-Superior areas, considered.

Gulf Resources, New York, 125 miles, gas, gathering system, from Lopena area in Zapata County to a point in La Salle County, Texas, planned.

Hope Natural Gas Co., Clarksburg, W. Va., 45 miles, gas, from West Virginia to Pittsburgh area, planned, 20 miles, 24-inch, gas, in Wertzel and Monongalia counties, W. Va., authorized.

Humble Oil & Refining Company, Houston, 116 miles, gas, gathering various sizes, southwest Texas, contracts let on 57 miles to O. R. Burden Construction Corp. and H. B. Zachry Co.

Iron Ranges Natural Gas Co., 115 miles, gas, from Itasca and St. Louis counties along route of Mesabi range from Grand Rapids to Aurora, Minn., $5 million, FPC authorization.

60 miles from Duluth to Silver Bay, Minn., FPC authorization.

Michigan Wisconsin Pipe Line Co., Detroit, 311 miles, gas, Marshfield to Appleton, Wis., 66 miles, Illinois, Indiana, and Michigan, 5,280 hp station at Marshfield, $24 million, planned.

Midwestern Gas Transmission Co., Houston.

504 miles, 24-inch, gas, from Minnesota-Canada border near Winnipeg to Marshfield, Wis., $52 million, before FPC.

Missouri-Kansas-Texas Railroad, 1400 miles LPG line, Midland, Texas, area to St. Paul-Minneapolis, Minn., and Madison; Wis., $55 million, planned.

Natural Gas Pipeline Company, Chicago, 29 miles, 10-inch lateral, in Oklahoma, before FPC.

Northern Natural Gas Company, Omaha.

171 miles, main line extensions, 66 miles, main loops, 139 miles, branch lines, 6,000 hp additions, to extend system from Minneapolis to Duluth-Superior area, $25.7 million, contracts let on 315 miles to Williams Bros. Co. and R. H. Fulton & Co.

46 miles, main line extensions, 191 miles, loops, 1,767 miles, branch lines, and 45,400 additional hp, in Iowa, Minnesota, South Dakota, Nebraska, Wisconsin and Illinois, $76.7 million, FPC authorization.

37 miles, 30-inch, Bushton compressor station to Otis field, Kansas, 7,000 additional hp at Bushton, and development of underground storage facilities at Otis field, $20 million, before FPC.

Ohio Fuel Gas Co., 59 miles, gas, 4-24-inch main lines, in Belmont, Carroll, Cuyahoga, Fairfield, Logan, Lorain, Marion, Muskingum, Stark and Wayne counties, Ohio, $5.1 million, planned.

Pacific Gas & Electric Co., San Francisco, 296 miles, 36-inch, gas, from Klamath Falls, Ore., to Antioch, Calif., southern section of line from Canada to California, before California Public Utilities Commission.

131 miles, 34-inch, loops, Topock-Milpitas, before FPC.

42 miles, 30-inch, gas, Pittsburg to Irvington, Calif., planned.

Pacific Gas Transmission Co., San Francisco, 614 miles, 36-inch, Kingsgate B.C. to Klamath, Ore., northern section of Canada to California line, before FPC.

Pacific Lighting Gas Supply Co., 128-mile, 34-inch, gas, main line from Topock, Ariz. to Newberry, Calif., authorized.

Pacific Northwest Pipeline Corp., Salt Lake City, 100 miles gas, gathering lines in San Juan Basin, Garmesa, Piceance Creek, and Big Piney Fields, $3.5 million, planned.

59 miles, 16 and 20-inch, gas, from a point on main line near Camas, Wash., to Salem, Ore., $6.1 million, before FPC.

Permian Basin Pipeline Company, Omaha, 83 miles, 16-inch, gas, from Pioneer's proposed facilities to Spraberry, Texas, and 3,960 hp compressor station, $5 million, before FPC.

Piedmont Gas Co., Hickory, N. C., 78 miles, 2-8 inch, gas, from connection with Transcontinental Gas Pipe Line to serve customers in North Carolina, $2.6 million, authorized.

Pioneer Gathering System, Inc., Amarillo, Texas, pipe line facilities in Texas costing $3.7 million, before FPC.

Pioneer Natural Gas Co., Amarillo, Texas, 62 miles, 10-inch main, Pampa, Texas, to Canyon, in Randall County, Texas, 20 miles, small diameter, gathering, 4,000 h.p. stations, $4.5 million, planned.

Phillips Petroleum Co., 25 miles, 6 to 20-inch, gas, South Eunice, New Mexico area, planned.

52 miles, 4 to 20-inch, gas, Gaines County, Texas, planned.

44-mile, 6-inch, products line, from Rocky pump stations to Amarillo, Texas, planned.

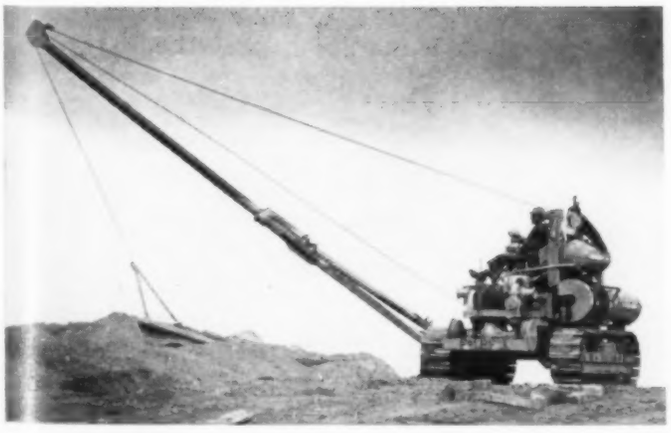
Rio Gas Gathering Co., San Antonio, 97 miles, 3 to 8-inch, gas gathering, South Texas, to supply gas to El Paso Natural Gas Company, planned.

Shamrock Oil & Gas Company, 49 miles, 20-inch, gas, Dumas to Amarillo, Texas, planned.

Southern California and Southern Counties Gas Cos., Los Angeles, 200 miles, 34-

on 122-mile 30" line

Cleveland 190 backfilled 7,000-8,000 cu. yds. per day



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inch, from Nevada-California border to point near Fullerton, Calif., $44 million, before Public Utilities Commission.

Southern Natural Gas Company, Birmingham, 490 miles, 16-24-inch, loop lines, gas, between Gwinville, Miss., and Wrens Ga; 62 miles, 14-inch, loops, along Atlanta-Macon line; 53 miles, 6⅝ to 14-inch, loops, along various branch lines. 3,140 additional hp at Gallion and Elmore, Ala. and Wrens, Ga. 60 miles, 20-inch, loops, in Louisiana between Franklinton and White Castle and South of Toca. Lateral lines south of Gwinville and west to Cranfield field. 8,720 hp added at Franklinton, White Castle, Patterson and Brookhaven, contracts let on 399 miles to Sharman, Allen, Gay & Taylor; Oklahoma Contracting Co.; Harbert Construction Corp.; C. S. LeNoir Construction Co.; and Buchanan Contracting Co.

Tennessee Gas Pipeline Co., Houston, 21 miles, 16-inch, 2 miles, 12¾-inch, gas, Louisiana coast, Vermillion, Blocks 46 and 64, $2.9 million, before FPC.

158 miles, 36-inch, looping system in Louisiana and Mississippi, to supply Midwestern additional gas at Portland, Tenn., $61.4 million, authorized.

Texas Eastern Transmission Corp., Shreveport, La.

65 miles, gas, Delmont, Penn., to Lambertville, N. J., before FPC.

40 miles, Lambertvile to Linden, N. J., before FPC.

350 miles, 24-inch, coal slurry, West Virginia to New York, considered.

Texas Electric Service Company, Fort Worth, 300 miles, gas, Old Ocean field to Fort Worth, Texas, $25 million, considered.

Texas Gas Gathering Corp., Shreveport, 36.6 miles, gas, gathering system in Rodney Field, Jefferson County, Miss. and from North and South Locust Ridge, Lake St. John Field in Tensas and Concordia parishes, La., $855,413, before FPC.

Texas Gas Transmission Corporation, 246 miles, 26-30-inch, loops, between Eunice, La., and Lebanon, Ohio, 102 miles, supply lines, south Louisiana, and addition of 15,760 hp, $40 million, contract let to Houston Contracting Co., Western Pipe Line, Inc., and Brown & Root, Inc.

Texas Illinois Gas Pipeline Company, Chicago, 16,000 additional hp to stations at Lufkin, and Marshall, Texas; Texarkana, Malvern, Searcy, and Biggers, Ark.; Jackson, Mo.; and Hammond, Ill., $3.9 million, FPC examiner approval.

371 miles, 30-inch, loops, and 45 miles, laterals, gas, 6,700 hp station in Victoria County, Texas, $43.5 million, before FPC.

Transcontinental Gas Pipe Line Corp., Houston. 149 miles, 36-inch, 80 miles, 30-inch, main loops, 34 miles, 20, 24-inch gathering, compressor stations at Nueces County, Texas and St. Helena Parish, La., additional hp in eight stations, $51 million, before FPC.

13 miles, 24-inch and 18 miles, 20-inch loops, Louisiana, FPC authorization. 14 miles, 16-inch laterals, 1-mile, 12-inch lateral, Louisiana, $2.1 million, FPC authorization.

Transwestern Pipeline Company, Houston, 1,305 miles, 24- and 30-inch, gas, main line, from West Texas and Oklahoma-Texas Panhandle area to Topock, Ariz., $193 million, FPC authorization. Contracts let to Houston Contracting Co., H. C. Price, and R. H. Fulton & Co.

Underground Storage & Exploration, Upper Darby, Penn., 394 miles, 12-inch LPG, from Moundsville, W. Va. to Newark, N. J., $9 million, approved.

95 miles, 6-8 inch, laterals to Mauch Chunk, Penn., and to Philadelphia, planned.

United Gas Pipe Line Company, Shreveport, La., 27 miles, 20-inch, gas, Empire, La., vicinity, contract let to Houston Contracting Company.

Valley Gas Transmission, Inc., Houston, 160 miles, 3 to 8-inch, gas, gathering, in Hidalgo, Brooks, Starr and Jim Wells Counties, Texas, $15 million, before FPC.

Wabash Pipe Line Co., 38 miles, products, Griffith, Ind., to Lake Calumet, Chicago, contracts let to Contracting & Materials and Morrison Construction Company.

Wilcox Crude Oil Corp., Shreveport, La., 20 miles, crude line in east central Louisiana, $500,000, planned.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. government.

Alaska-Yukon Refiners and Distributors, Ltd., Edmonton, Alta., 150 miles, products, serving Alaska and Yukon territory, $3.5 million, planned.

Alberta Gas Trunk Line Company, 386 miles, 26-36-inch, gas, main, Berland River area, Alberta, to Alberta-British Columbia border; and 235 miles, 8-18-inch, gas, gathering, Alberta, $100 million, before Alberta Oil and Gas Conservation Board.

Alberta Natural Gas Company (Jointly owned by Westcoast Transmission Co. and Alberta & Southern Gas Co. Ltd.) 110 miles, 36-inch, gas, Alberta border to British Columbia-Idaho border, supply gas to Pacific Gas & Electric Co., $40 million, planned.

Arab League Oil Committee, large diameter crude line from Persian Gulf to Mediterranean Coast, $500 million, considered.

Aurine Alps Railway & Pipeline, 200 miles, crude, Venice to Munich, Germany, considered.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India, contracts let on 270 miles, 16-inch to Stewarts and Lloyds.

Cartier Gas Corp. (St. Maurice Gas, Inc., and Consumers Gas Co., Toronto), 170 miles, gas, Montreal to Quebec City, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Creole Petroleum Co., 44 miles, 12-30-inch, gas, Bachaquero to Tia Juana, Venezuela, planned.

Development and Resources Corp. 70 miles, 8 inch, gas, from Agha Jari oil field to Ahwaz, Iran, planned.

Entre Nazionali Idrocarburi, Rome, Italy, crude, from Qum field in Iran to the Mediterranean Sea, considered.

Foothills Pipe Line, Ltd., 500 miles, 12 to 16-inch, LPG, from Alberta to Pacific Coast, $80 million, considered.

Gibson Crude Oil Purchasing Co. Ltd., 170 miles, crude, Milligan Creek, B. C. to Grande Prairie, Alta., planned.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 880 miles, 6-8 inch, products from Edmonton to Winnipeg, $35 million, partial authorization.

Independent Pipe Line Co., 2,019 miles, 34-36-inch, crude, Edmonton to Montreal, 23,000 pump horsepower, $395 million, before Borden Commission.

Interprovincial Pipe Line Company, 350-mile extension from Toronto to Montreal, looping line from Edmonton to Toronto, crude, $240 million, considered.

Iraq Petroleum Company, 250 miles, 30-32-inch, crude, Kirkuk, Iraq, to Syrian border; and 65 miles, 30-32-inch, crude, Rumaila to Fao, Iraq, contracts let to Turriff-Burden Ltd.

Island Transmission Company Limited, Nanaimo, B.C., 25 miles, 10-inch, gas, from point near Vancouver, B.C. to Vancouver Island, 67 miles, 10-inch, laterals to Victoria and Nanaimo, B.C., $14 million, planned.

Mid-Continent Pipe Lines, Ltd., 1500-mile, 30-inch crude, Edmonton to Chicago, planned.

NATO, 211 miles, crude, 6-inch, between Malatya-Cetinkaya-Erzincan, Turkey, $6 million, bids asked.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

1000 miles, 38 inch, crude, from central Iran to the Turkish Mediterranean coast, considered.

500 miles, 8-inch, products, Teheran to Meshed, Iran, contract let on 250 miles to Williams Bros. Co.

Pacific Petroleums Ltd., 213 miles, 3-8-inch, crude, gathering, Milligan Creek and Blueberry fields to Dawson Creek, planned.

Palestine Economic Corp., New York, 135 miles, 16-inch, crude, Eilat to Beersheba, Israel, to be completed July 1960.

Peace River Oil Pipe Line Co., Ltd., 70-mile, crude, Swan Hills to Iosegun Junction, approved.

230 miles, 8-inch, crude gathering, from fields in northeast British Columbia to Dawson Creek, B. C., and Grande Prairie, Alta., and to existing lines at Sturgeon Lake, $8.5 million, planned.

Pembina Pipe Line, Ltd., Edmonton, 1,200 miles, LPG, from Alberta gas fields to eastern Canada, planned.

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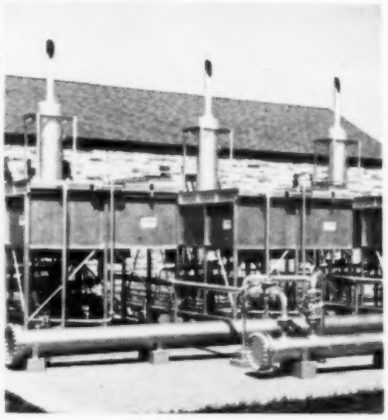

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Petroleos Mexicanos, 38 miles, 4 inch, products, from Mexico City to Toluca, $500,000 planned.

126 miles, 4, 6 and 8 inch, products, from Mexico City to Cuernavaca and Puebla, $2.5 million, planned.

214 miles, products, Monterrey to Torreon, $6.5 million, planned.

Pipelines of Puerto Rico, Inc., 95 miles, 8-inch, products, Penuelas to San Juan, Puerto Rico, planned.

Producers Pipelines Ltd., 25 miles, 4-inch, crude, Arlington Manor pool to Parkman pool, Saskatchewan, planned.

Rangeland Pipe Line Company Limited, 111 miles, 8-inch, crude, southeastern Alberta to Calgary, $3 million, planned.

Sociedad Nacional de Oleoductor, 75 miles, crude, from Santiago-to-Valparaiso, $3 million, planned.

Societa Nazionale Metanodotti, 650 miles, 18-inch, crude, Genoa, to Milan-Cremona-Torino, Italy, and Aigle, Switzerland, with extensions to Karlsruhe and Munich, Germany, planned.

Societe d'Etude du Pipe Line Sud-European, Paris, 419 miles, 30-inch, crude, port of Lavera to Strasbourg, with lateral extending 40 miles to Karlsruhe, Germany, approved by French cabinet.

Standard-Vacuum Oil Company, 60 miles, 8-inch, gas, main, in South Sumatra, considered.

Ste. d-Etudes de Pipeline Intercontinetaux, Paris, 1,400 miles, 30-40-inch, gas, from Hassi R'Mel field in central Algeria across Mediterranean, through Spain, France and into West Germany, considered, Fish International Corporation making engineering and feasibility studies.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line Multan to Lyallpur, planned.

Trans-Canada Pipe Lines Limited, Toronto, compressor stations at Ignace, Geraldton and Hearst, Northern Ontario, and Maple, north of Toronto, $15.5 million, planned.

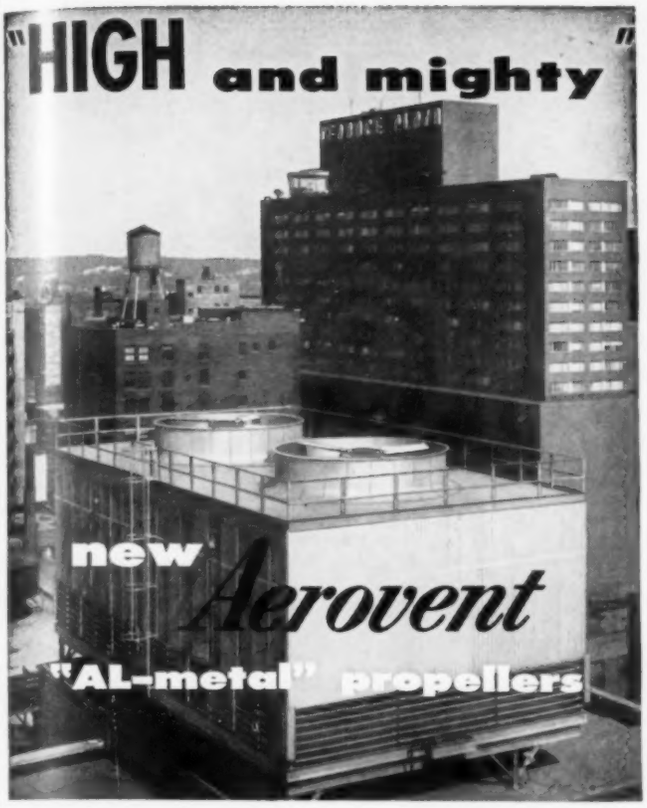
Trans-Prairie Pipelines, Ltd., Edmonton, crude line, from Weyburn field to Regina-Moose Jaw areas, $5 million, considered.

Crude line from Milligan Creek area to Dawson Creek and Fort St. John refineries, planned.

Union Gas Company of Canada Limited, 45 miles, 8-inch, gas, main, Stratford to Goderich, Ontario; 10-miles, 8-inch, main, to Amhertburg; 10-miles, 12-inch, lateral, Galt to Brantford, planned.

Westcoast Transmission Company, Ltd., 250 miles, 30-inch, gas, Taylor to Fort Nelson, B. C., planned.

Williams-McWilliams Industries, Inc., New York, 441 miles, 6-inch, crude, Villa Montes, Bolivia to Villa Hayes, Paraguay, considered.



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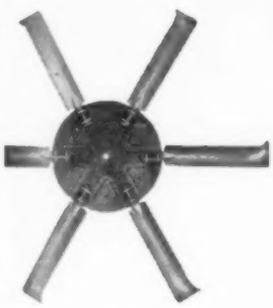

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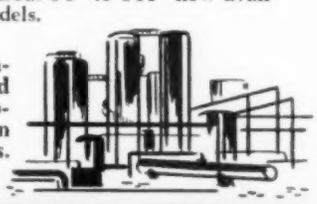

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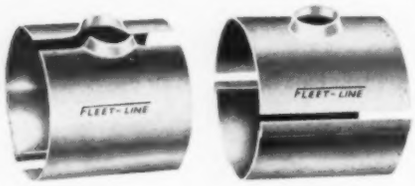
REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



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Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina, 621 miles, 12-inch, products, Mendoza to San Lorenzo, Argentina, $19 million, planned.

281 miles, 12¾ inch, crude, Pichanal to San Miguel Tucuman to Techint, S. A., planned.

450 miles, 16-inch, crude, from Neuquen Province to Bahia Blanca, planned.

Texas Illinois Receives FPC Examiner Authorization

Texas Illinois Natural Gas Pipeline Company was granted authorization by an FPC presiding examiner to install 16,000 horsepower in eight existing stations and construct 10 miles of 8-inch gas line in Texas.

The decision is subject to review by the Commission. TING will add 2,000 hp in eight stations along its system in Texas, Arkansas, Illinois and Missouri at a cost of about $4 million. The pipe line will be laid in Hidalgo and Starr counties, Texas. Included in the decision, South Texas Natural Gas Gathering Company, subsidiary of Coastal States Gas Producing Company, was authorized to construct gathering facilities and sell gas to Texas Illinois.

Additional horsepower will allow Texas Illinois to take 20 MMcf of gas daily and boost its system capacity to 524 MMcf daily.

Superior Oil Co. Plans 16-Inch Aluminum Line

Superior Oil Company will install a 16-inch, 1,800-foot aluminum pipe line in Lake Maracaibo, Venezuela. The underwater line will have a capacity of 2,000 gallons per minute delivered to the fire protective system at Superior's tank farm in the Altagracia area. The line will connect with a steel line from shore to tank farm.

Turriff-Burden Ltd. Awarded Contract for Iraq Crude Line

Turriff-Burden Ltd., has been awarded a contract by the Iraq Petroleum Company, Ltd., for construction of 315 miles of 30 and 32-inch crude lines in northern and southern Iraq.

The northern section includes 250 miles from Kirkuk to the Syrian border; this completes the crude line from the Kirkuk fields to Tripoli, Lebanon. The southern section consists of 65 miles south of Basrah, connecting Rumaila and Fao. Construction is expected to be completed within two years.

Turriff-Burden Ltd., is owned by Turriff Construction Co. Ltd., of England, and Burden International Ltd., of Canada. Burden International Ltd., is owned by O. R. Burden Construction Corporation and J. E. Burden.

Contracts Let on Extension Of Wabash Pipe Line Company

Contracts have been let to Contracting & Materials and Morrison Construction Company to build a 38-mile extension of the Wabash Pipe Line products system.

The new line will extend from Griffith, Ind., to Lake Calumet in Chicago. Wabash carries products from Wood River, Ill., to Griffith, Ind.

Katy Alters Plans For Products Pipe Line

The Missouri-Kansas-Texas Railroad has cancelled its plans to construct a LPG line from Texas to New York but announced it is planning to build a line from West Texas to the upper Midwest.

The proposed $55 million project would carry propane, butane and natural gasoline from the Midland, Texas, area to McPherson, Kans. From there, two separate lines would carry products to Madison, Wis., and Minneapolis-St. Paul, Minn.

National Iranian Oil Company Lets Contract on Products Line

Williams Brothers Company has been awarded a contract to construct about 250 miles, 8-inch products line for the National Iranian Oil Company. The project is part of the 500-mile line to be laid from Teheran to Meshed, Iran.

Shamrock Oil & Gas Plans 49-Mile, 20-Inch Gas Line

Shamrock Oil & Gas Company will construct a 49-mile, 20-inch gas pipe line from Dumas to Amarillo, Texas.

United Gas Lets Contract To Houston Contracting Co.

United Gas Pipe Line Company has awarded a contract to Houston Contracting Company for construction of 27 miles of 20-inch gas lines and a crossing of the Mississippi River consisting of 12-inch pipe in the vicinity of Empire, La.

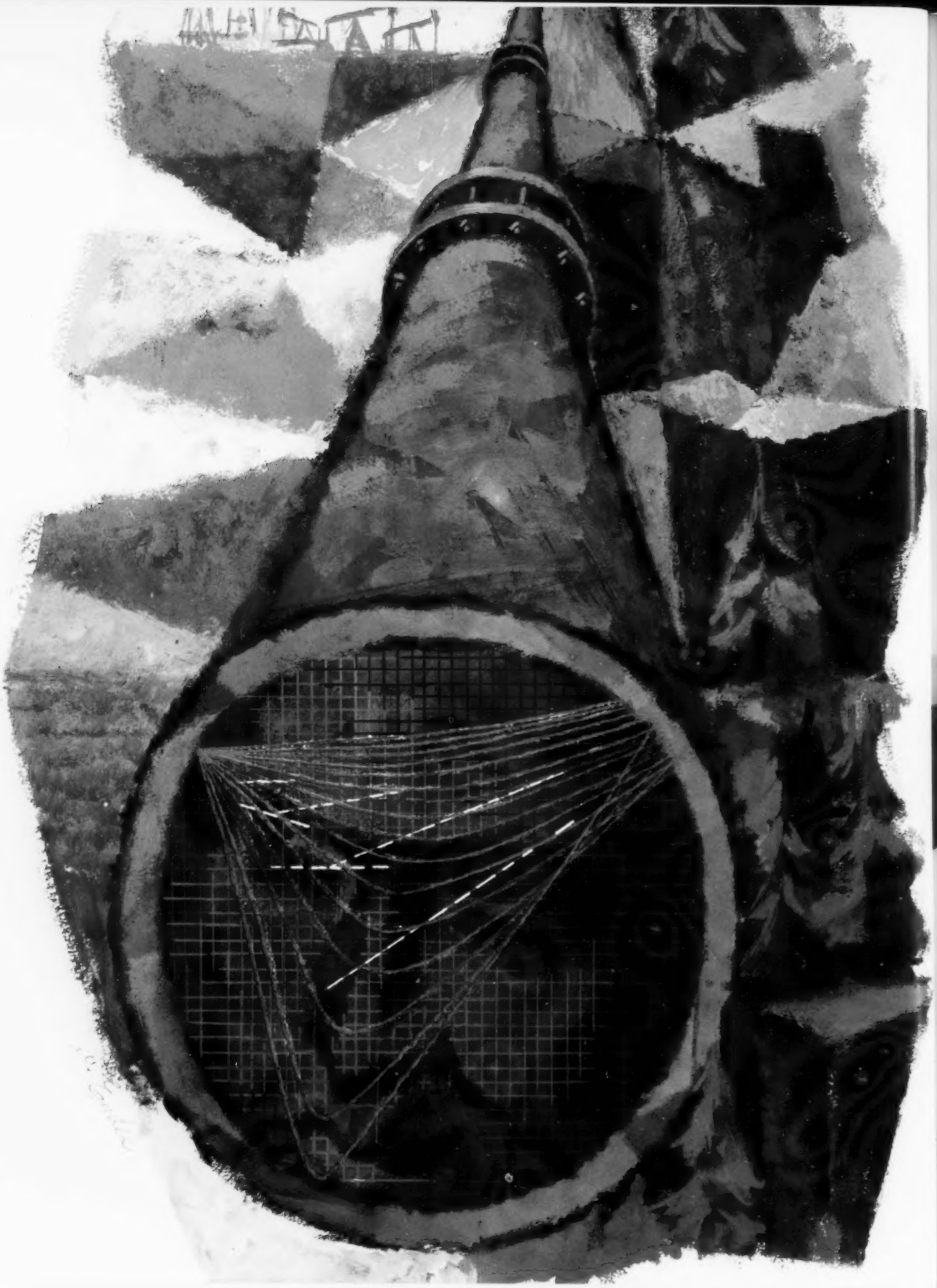
The Biggest Boots in the Industry

Sam Carline, Inc. lay barges support the biggest boots in the pipeline industry, boots of men trained to do the biggest jobs and do them quickly and efficiently. Big Boots take over when a Carline lay barge comes on the scene, as it did in the 10,000-foot, 8-inch line of United Gas, pictured near Berwick in August. Big Boots have given Carline a solid network of achievement in the Deep South.

SAM CARLINE, Inc.

CALL 9031 • BERWICK, LOUISIANA

For more data on advertised products, use Readers' Service Cards, last page.



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compressors and
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A graph of gas compressibility factors veiling the face of an imaginative man, at left, thematically shows the complexities of the tremendous task of moving the nation's daily production of natural gas to virtually every community. The Dresser companies are leaders in the manufacturing of vital equipment for all phases of this vast gas industry. Throughout the free world's oil, gas, chemical and electronic industries, Dresser products and technical services have long been known as the standard of comparison.

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PIPE LINE INDUSTRY

What's Happening

among MEN in the INDUSTRY

Joe **T. Dickerson** will retire as president of **Shell Pipe Line Corporation** to become executive vice president of the **Mid-Continent Oil and Gas Association** January 1, 1960.

Joe T. Dickerson

In the newly created Mid-Continent post, Dickerson will be headquartered in Washington. As executive vice president, he will direct the assembling of factual material on the oil and gas industry for use by congressmen, government officers, editors, columnists, commentators and reporters. He will give continuous attention to industry problems in relation to Congress and Federal Government and keep the association informed concerning legislation affecting the industry.

Dickerson joined **Shell Oil Company** in 1927 as attorney in the Tulsa office and in 1933 became manager of its legal department. In 1940 he was named manager of legal department in Houston. He moved to New York as head of legal department in 1945 and in 1946 returned to Houston as general attorney on regional staff, exploration and production.

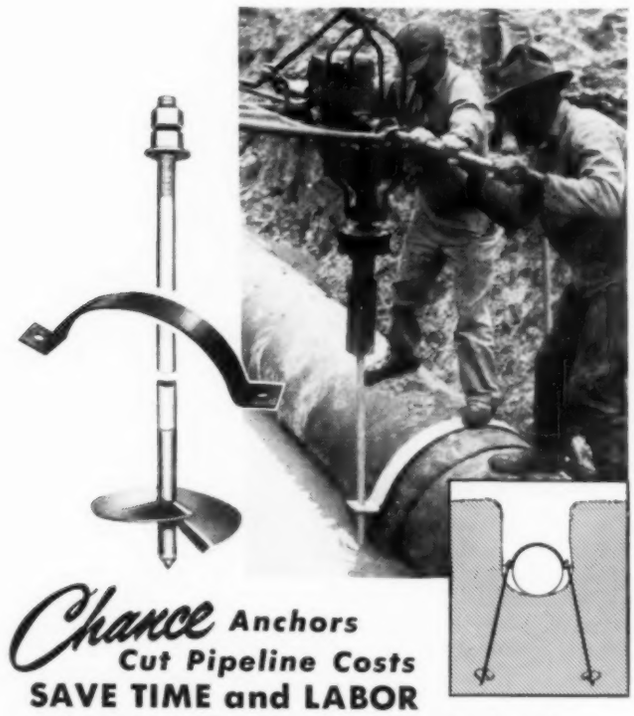
From 1951 to 1954, he was vice president of Shell Oil Company, and in 1954 he was elected president of the pipe line corporation.

J. A. Horner, secretary of Shell Oil Company, will succeed Dickerson as president.

O. R. Stites, general attorney and member of the board, **Cities Service Gas Company,** has retired after over 20 years service with the company.

He joined the firm in 1938 and was appointed general attorney in 1951.

Allan L. Piper has been named assistant manager of **Tidewater Oil Company's** eastern division, Transportation and Supply Department. Piper joined Tidewater in 1937 and has been assistant to the manager of Transportation Department in the western division.



Chance **Anchors**
Cut Pipeline Costs
SAVE TIME and LABOR

The modern, effective method of anchoring pipeline is with Chance Pipeline Anchors and Brackets. It is the lowest cost, easiest, surest way to keep pipe from floating. Can be installed with hand tools or light power equipment.

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There's VERSATILITY in your PIPE LINE SERVICE and Portability with...

U.S.

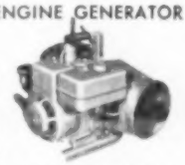
Portable U.S. Versa-Trailer standby emergency power units in sizes from 10 kw to 35 kw capacity provide single phase power for lights and 3-phase power for other requirements.

Versatile mobile power units provide for foolproof selection of desired current with selector plugs and cables.

Pipe Lines use convenient lightweight generating sets for lights, portable tools. Rugged construction.

ENGINE GENERATOR

Portable blowers are especially suited for ejecting smoke, fumes, stale, contaminated air, and for purging tank cars, field storage tanks, etc. Motor driven or engine blowers are available.



ENGINE BLOWER

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For more data on advertised products, use Readers' Service Cards, last page.

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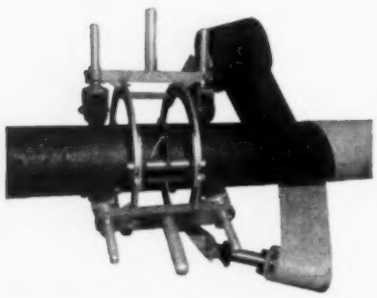
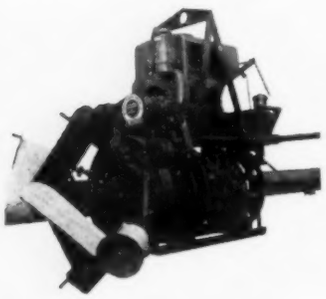
For More Dependable Equipment and Service

HERE ARE MACHINES THAT BRING ADDED EFFICIENCY TO YOUR TAPING AND CLEANING AND TAPING.



The MYOCO Tapemaster can use four arms to give any combination of tape and kraft or felt. Six various size machines available for ½" through 36" pipe; small machines use tape from ½" width through 9", large machines use 9" through 18" tape.



MYOCO Model OW Power Driven Cleaning and Taping machine combines two operations for increased speed of operations with less equipment. Line travel machines are available to handle pipe sizes 3" to 6", 6" to 12", and 14" to 20". A Wisconsin Model Vg4D V-type 4-cylinder heavy-duty air cooled engine, combined with the design and engineering features of this machine, guarantees uninterrupted service.

When you use MYOCO pipeline equipment, you quickly find that servicemen are experienced and available twenty-four hours a day, with fast transportation available to serve you in any way; efficient equipment operation is assured by periodical checks; and if possible, parts and supplies are shipped the same day ordered.

MORRIS-YOUNG-OWENS CO. PIPELINE EQUIPMENT AND SUPPLIES MYOCO

MORRIS-YOUNG-OWENS CO.

PIPELINE EQUIPMENT AND SUPPLIES

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In Canada: MYOCO LTD., 30 Bloor St. West Toronto 5, Ontario, Canada, Tel. WA 2-9444

William S. Tarver

Marc Baum

Southern Natural Gas Company announces the election of **Marc Baum** as vice president, Sales and Rates. **William S. Tarver** was elected secretary, and **Peter G. Smith** was appointed assistant secretary of the company.

Peter G. Smith

Baum has been affiliated with Southern Natural's former parent firm, **Federal Water and Gas Corporation,** since 1926. In 1945 he joined Southern Natural as a rate specialist and prior to his promotion had been manager of Southern's Sales and Rate Department. Tarver joined the company in 1952 as general attorney. He had served as associate general counsel for the Petroleum Administration for Defense in Washington. Smith has been with the company since 1955. Previously he was with the law firm of Hughes, Hubbard, Blair and Reed, New York counsel for Southern Natural.

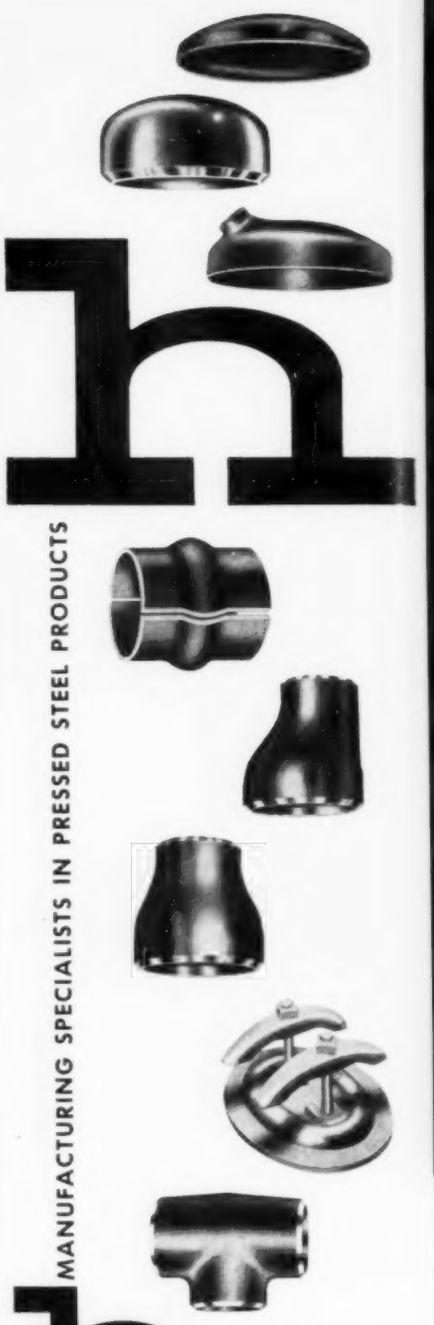
Richfield Oil Corporation announces the appointment of **John W. Gendron** as general manager of Transportation and Supply Department. Gendron came to Richfield from Tidewater Oil Company where he had been assistant general manager of the eastern division. Previously he had been assistant to the president at Tidewater.

F. B. Behrens will assume duties of assistant general manager of transportation and supply while continuing as manager of supply and distribution. **M. E. Tracy** has been assigned the position of assistant manager of Supply and Distribution Department.

R. E. Hull, after 31 years service with **United Gas Corporation,** has retired. He will be succeeded as comptroller by **Norman J. Luke** who has been assistant to the comptroller the past two years.

W. G. Meece, assistant to the treasurer since 1947, has been promoted to assume the duties of a new position as director of special services.

Alan D. Hall has been named comptroller of **Northern Ontario Natural Gas Company Limited.** He will be responsible for all accounting methods, controls, procedures and the preparation of financial statements. Before joining the company in 1959, Hall was secretary-treasurer of the Universal Cooler Company Limited.



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HACKNEY IRON & STEEL CO.

general office: ENID, OKLAHOMA

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The **HACKNEY** Diamond is Your Assurance of ACCURACY and DEPENDABILITY

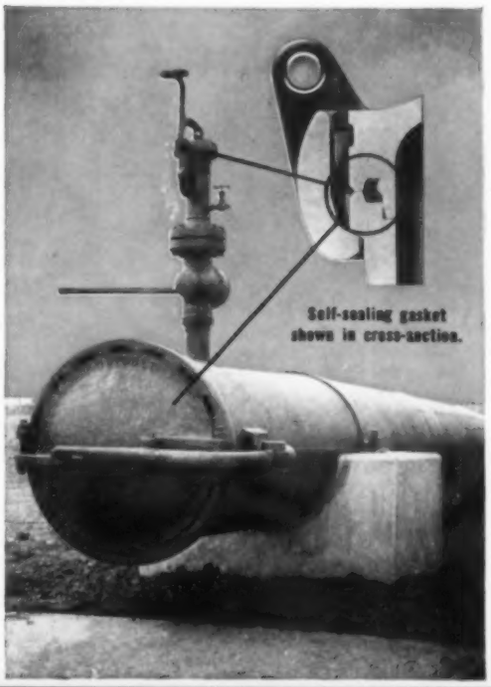
Write for Current Stock List

If you are a pipeliner

you'll appreciate this self-sealing gasket in UNIBOLT scraper trap and blowdown closures

Little things . . . like the gasket for a scraper trap or blowdown closure for example . . . can be a big headache. But not this one. It is the self-sealing gasket used in UNIBOLT pipeline couplings. The UNIBOLT design makes line pressure do the sealing. And this design practically encloses the gasket in steel so that when the closure is opened and closed the gasket is hardly disturbed. Made of oil- and gas-resistant Hycar nitrile rubber, this gasket will last indefinitely under normal conditions.

UNIBOLT scraper trap and blowdown closures are hinged for easy operation. Release only two bolts and the closure swings open and shut like a door. No heavy lifting. No time-consuming multi-bolt flanges. Write for complete information.



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BLUE FLAG®
Fiber Glass Wrap

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—your assurance of maximum protection

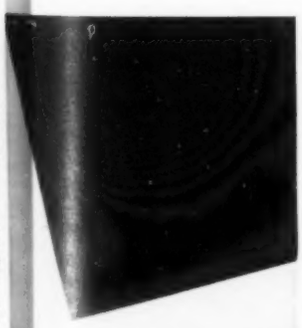
J-M Blue Flag Wrap is made of specially formulated, chemically resistant glass fibers which are parallel reinforced with continuous strands of fiber glass yarn for high-speed application.

1 J-M Blue Flag Wrap—for enamel reinforcement

Johns-Manville Blue Flag Wrap is a uniformly porous fiber glass wrap. It lets enamel bleed through quickly . . . actually becomes an integral part of the over-all pipe coating. Like steel reinforcement rods in concrete, Blue Flag reinforces the pipe enamel giving it extra strength, hence extra working life. Because it is made of inert, inorganic fiber glass, this wrap cannot rot, decay, or absorb moisture.

With L.O.F. Glass Fibers Company joining the J-M family, buyers of pipeline wraps and tapes are now additionally served . . . by an enlarged staff of Johns-Manville sales and technical personnel operating out of 56 sales offices . . . by expanded distribution facilities . . . by the addition of 7 strategically located plants . . . by expanded research and product development laboratories. For further information, write to J-M, Box 158, N.Y. 16, N. Y. In Canada, Port Credit, Ont.

ion and service life for pipelines



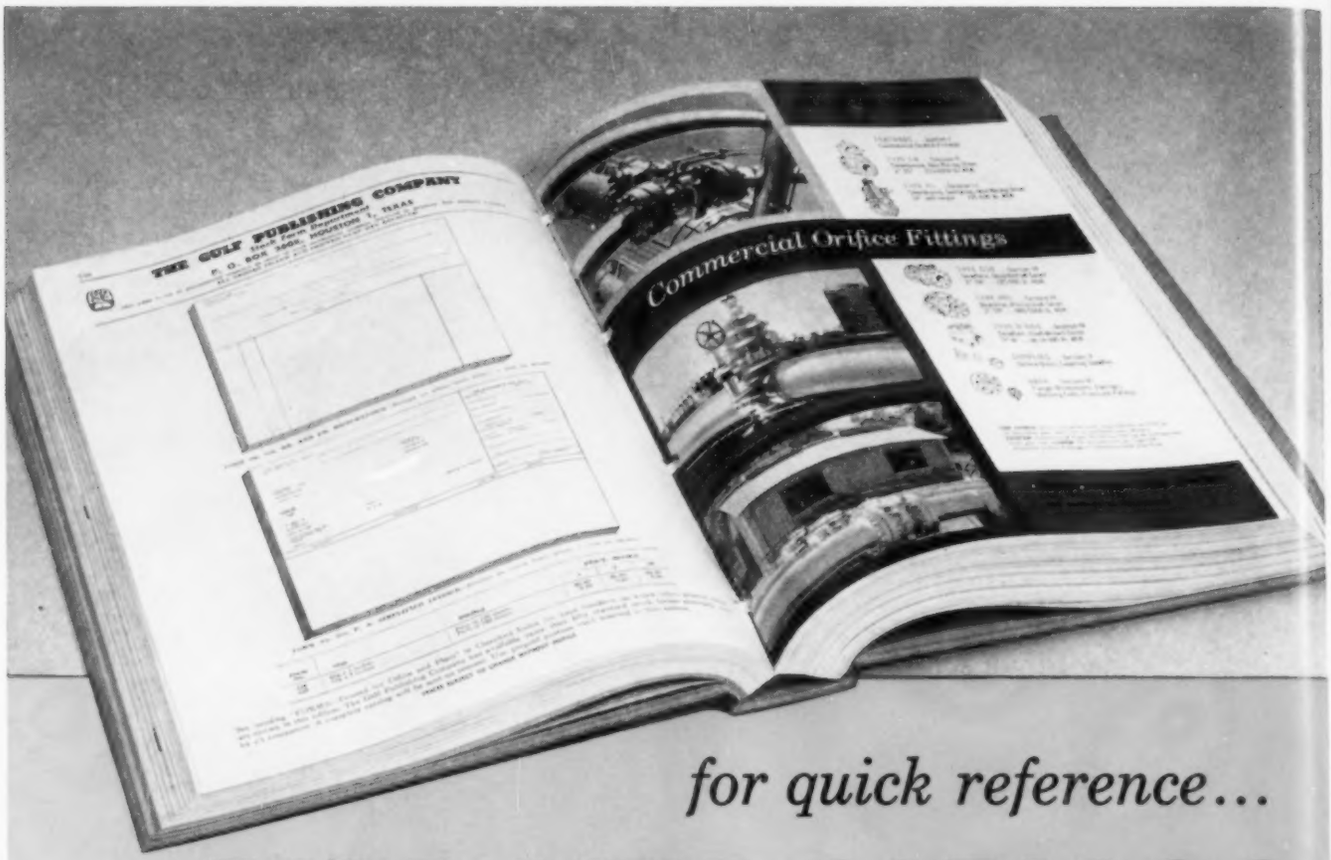
J-M Transhield Felts, asbestos reinforced with parallel glass fibers, come in 2 types for field or mill wrapping: #15 Transhield (heavyweight); #8 Transhield (standard). #15 plain Asbestos Felt also available.

2 J-M Transhield—for a tough outer shell

Apply an outer wrap of this inert, inorganic asbestos felt—and give your pipeline investment *complete* long-life protection. Asbestos, the magic mineral, comes from the ground . . . is always at home in the ground . . . won't rot or decay. In J-M Transhield these asbestos fibers are impregnated with a coal tar or asphalt saturant to form, literally, a flexible covering of stone, providing a strong, highly durable outer protective shell.

JOHNS-MANVILLE

JOHNS MANVILLE JM PRODUCTS



for quick reference...

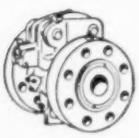
the PIPE LINE CATALOG

is the place to look for

COMMERCIAL ORIFICE FITTINGS

TYPE CN
Chambered, Non-Rising Stem
2"-20"... 125-2500 lb. ASA

TYPE CS
Chambered, Swinging, Non-Rising Stem
24" and larger ... 125-600 lb. ASA



TYPE DPL
Deadline, Pin-Locked Cover
2"-24"... 600-2500 lb. ASA

TYPE DSB
Deadline, Stud-Bolted Cover
2"-24"... 125-600 lb. ASA

TYPE D-600
Deadline, Stud-Bolted Cover
2"-6"... up to 600 lb. ASA

COMMERCIAL IRON WORKS

2424 Porter Street, Los Angeles 21, California

C. F. **McCoy**, vice president of **Sinclair Pipe Line Company**, has resigned to become a vice president of **Sinclair Oil & Gas Company.** In a newly created post, he will serve as administrative coordinator for industrial relations, personnel and safety, public relations, purchasing, traffic and office services departments.

C. F. McCoy

He joined the pipe line company in 1950 and in 1956 was elected a vice president. He became a member of the board and was named to the executive committee in 1957.

C. G. **Campbell** has retired as assistant treasurer of **Transcontinental Gas Pipe Line Corporation** after 36 years service in the gas utilities industries. **W. A. Holcomb, Jr.** has been named manager of the insurance and pensions department.

Campbell came to Transco in 1949 during construction of the transmission system to New York. Holcomb succeeds **A. E. Bryan** who was elected assistant treasurer.

Richard E. Houser, former superintendent of the reservoir engineering department of **El Paso Natural Gas Company**, is now a partner of **Brokaw, Dixon & Magee.** The firm is composed of consulting oil and gas engineers and geologists of New York and Houston. Houser will be in charge of the Houston office.

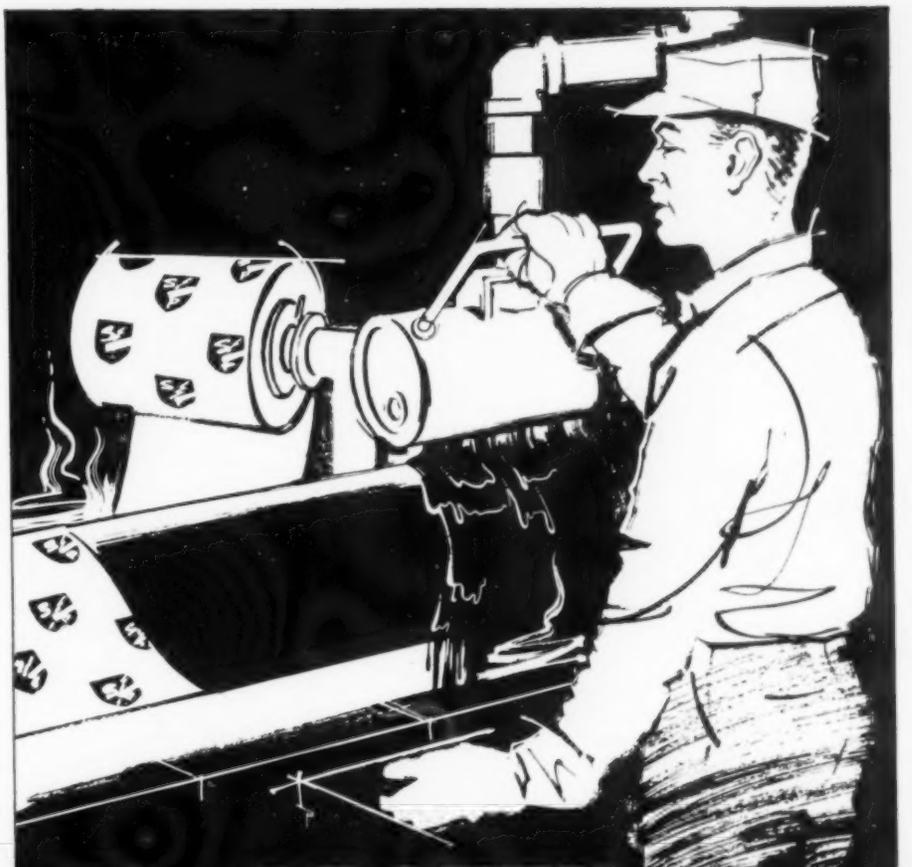
Service Pipe Line Company received the Joseph A. Holmes award for working more than 10 million man-hours without an accident involving fatality or permanent total disability.

The award covers the period from September 23, 1955, to December 31, 1958.

Charles I. Poole has opened offices as a natural gas consultant at Lubbock, Texas. Poole has worked with Pioneer Natural Gas Company for the past 11 years and recently served as division engineer distribution.

Ian N. McKinnon has been appointed to head the National Energy Board of Canada. McKinnon, chairman of the Alberta Oil and Gas Conservation Board, will serve two years on the federal board.

Other members who will serve 7-year terms include: **Dr. Robert D. Howland,** economic advisor to the Nova Scotia government; **Jules A. Archambault,** president of Canit Construction Co., Montreal; **H. Lee Briggs,** general manager of British Columbia Power Commission, Vancouver, and **Douglas M. Fraser,** Ottawa government economist.



The PROVEN METHOD for PIPEPROTECTION

The essence of pipeprotection is a perfect bond of the coatings and wrappings to the pipe and to each other. This bond must be maintained under all conditions — when the pipe is bent and during wide temperature variations. Otherwise, the coatings and wrappings would slip and creep and holidays would occur, permitting corrosive action on the pipe.

There are no other materials, generally available today for pipeprotection, that furnish the perfect bond to steel pipe that is provided by bituminous enamels and felt and glass wrappings when applied according to the rigid Standard Specifications of Standard Pipeprotection Inc.

Use the proven method for pipeprotection by ordering your c/w pipe from Standard Pipeprotection Inc.

standard pipeprotection inc.

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ST. LOUIS 17, MISSOURI

For more data on advertised products, use Readers' Service Cards, last page.

CATHODIC PROTECTION
Good-All
RECTIFIERS

NEW • NEW • NEW

Ask your Representative about the entirely NEW concept in Cathodic Protection! The Good-All

"AMP-O-MATIC"

Rectifier. Just set it and forget it . . . the Amp-O-Matic automatically ADJUSTS OUTPUT ITSELF!

GOOD-ALL ELECTRIC MFG. CO.
OGALLALA, NEBRASKA

FISHER finds it faster!

All-new 1959 Transistorized

M-SCOPE PIPE FINDER

only $189.50

- Greatest depth penetration
- Greatest tracing distance
- Pinpoint accuracy
- One year between battery changes
- Built-in battery testers
- 90% less maintenance costs

New, Transistorized
LEAK DETECTOR

- Finds leaks faster, more accurately
- Weighs 80% LESS than ordinary equipment

only $295.00

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ON THE LINE

Beauty Course for Diplomacy

A 6-week training course for American business executives bound for overseas is underway at American University, Washington, D. C. Intended to eliminate "Ugly Americans," the school is designed to improve our foreign relations by giving the executive a better understanding of the country in which he will work.

Executives will learn: rudiments of language of the host country, understanding of people of the country; basic ideas of economic and social life of the foreign country, and ability to better explain the American way of life.

School started September 14. Five more 6-week schools will be offered this year; any American business executive may enroll. Tuition is $500. The U.S. State Department and U.S. Information Agency are cooperating with the university on the program.

Competing with Imports

Combating the influx of imports in the small diesel tractors field, J. I. Case Company announces it will introduce in December a new line of small diesel tractors to compete in price with the European models.

Marc B. Rojtman, president of Case, commented that "by modern design and high-production precision tooling, we are able to compete and offer American precision quality and features on two small model diesel tractors that are actually lower in price than most European imported counterparts."

Drake Epic Told in Movie

Reliving the episodes of Edwin L. Drake in his rise to oil fame, a sound and color movie, "Born in Freedom" has been shown by several groups during oil industry's centennial year.

The film incorporates a special Centennial Year introduction narrated by TV commentator John Daly. Vincent Price plays the lead as Drake.

The film can be obtained through the API, 50 West 50th St., New York 20, N. Y., or Public Relations Department, Sun Oil Company, 1608 Walnut Street, Philadelphia 3, Pa.

Cathodic Protection Record

A 25-year corrosion-free leak record was set by Texas Gas Transmission Corporation's Corrosion Prevention Department. Since 1934 not a single corrosion leak has occurred on any of the new or reconditioned Texas Gas lines to which cathodic protection was applied immediately.

Go Modern—Go Gas

Go Modern—Go Gas and the Blue Star Home Symbol are the trademarks of the American Gas Association's national program to help builders and gas utilities to win a larger share of the new home market.

Sponsored by the Gas Home Bureau of the AGA, the program is designed by builders and utilities to offer prospective home buyers a guide to modernity and comfortable family living.

Minimum requirements for tract homes call for inclusion of AGA approved gas appliances for cooking, water and house heating, and provision for gas refrigeration, incineration, laundering and air conditioning where possible.

Support of the program is indicated with nearly 50 gas companies from all areas of the country planning active participation. Promotion items bearing the trademark include truck and bus cards, match books, decals, brochures, cigarette lighters and site signs for tract and model homes.

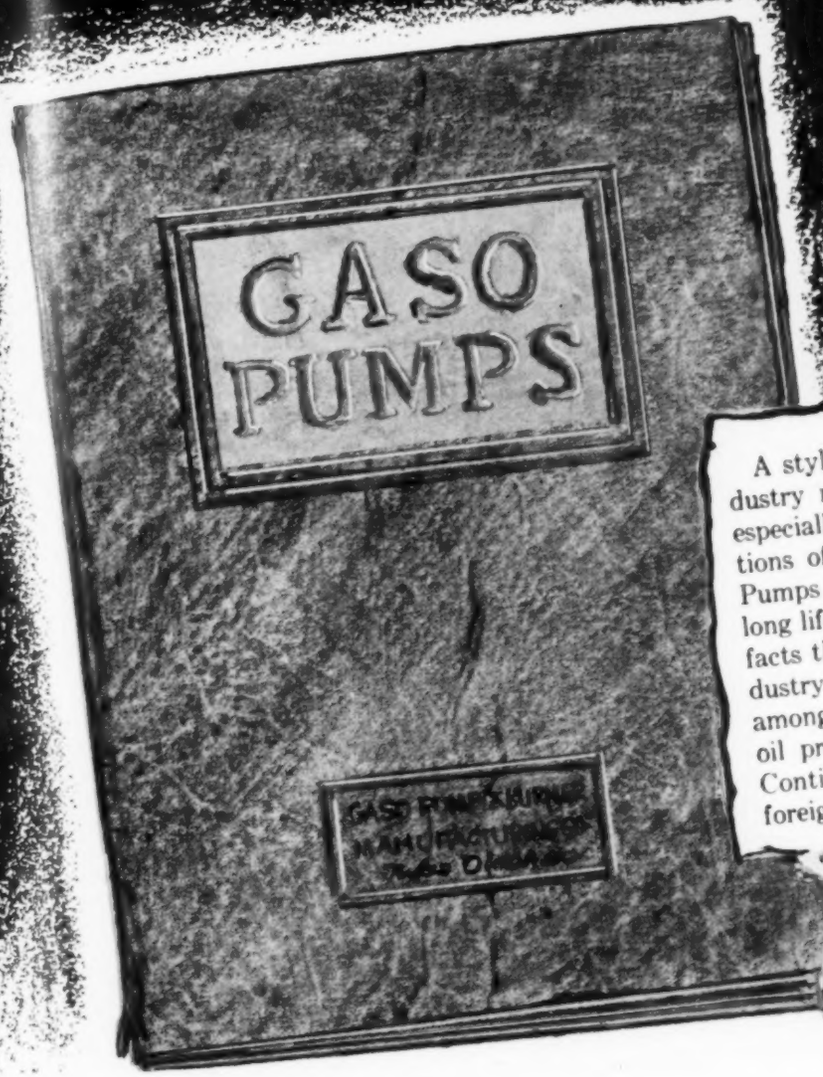
International Sales New High

International Harvester Company reports "largest sales activity of any single quarter in the company's history" for the third quarter of 1959. Sales of construction equipment and service parts amounted to $125,810,000—a gain of 25.6 percent over 1958's third quarter. Total sales for all operations amounted to $428,743,000—a 56.3 percent increase over the comparable 1958 period.

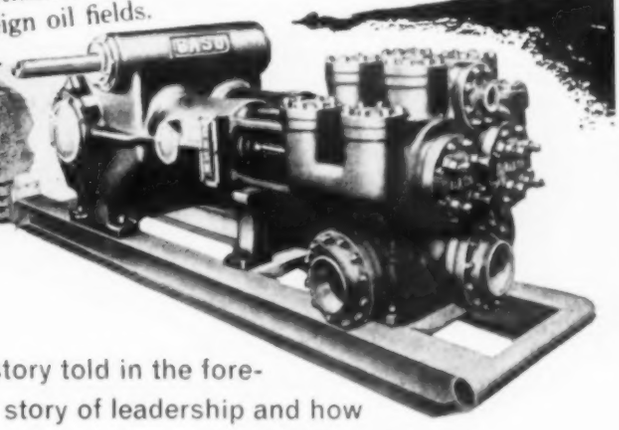
The total sales for the 1959 9-month period were $1,027,286,000, marking the first time the billion dollar level was exceeded in a similar period.

Net income for the 9-month period of $61,460,000 also is another high. Third quarter net profit was $30,077,000.

PUBLISHED 34 YEARS AGO ..Still True



A style of pump is offered to meet every Oil Industry need, and every item in our line has been especially designed to withstand the severe conditions of oil field and refinery service. That Gaso Pumps have met the tests of unflinching operation, long life and low maintenance cost is attested by the facts that over 12,000 have been sold to the Oil Industry in the past ten years and that we number among our customers practically all of the leading oil producing and refining companies in the Mid-Continent, as well as many in other domestic and foreign oil fields.



It is a far cry from this catalog, published 34 years ago, to our latest catalog, recently released. Today's Gaso line includes models to meet every need and condition within the capacity range of the pumps. Today's Gaso Pumps embody metals and design principles unknown in 1925.

But the story told in the foreword—a story of leadership and how it is maintained—is as true today as when it was first presented, 34 years ago.

Have you a copy of our latest catalog? If not, we'll be happy to send you one.

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Jaeger pays off with 600 cfm at 1700 rpm

This Jaeger rotary compressor, powered with the same GM 6-71 diesel used in other makes, produces 600 cfm of air with 100 fewer revolutions (1700 rpm instead of 1800), *consuming less than 1¼ lbs. of fuel.* Think of the long-term saving in fuel, and engine and compressor life. Other Jaeger sizes are comparably efficient. See your Jaeger distributor, or send for Catalog.

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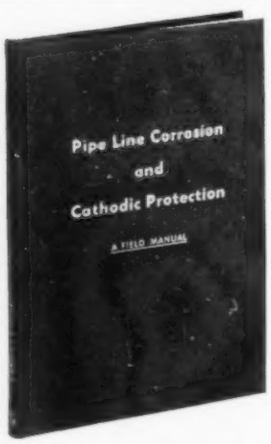

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WHO'S MEETING WHERE

October

AGA, 41st annual convention, Conrad Hilton Hotel, Chicago, Oct. 5-7.

NACE, northeast region, Lord Baltimore Hotel, Baltimore, Md., Oct. 5-8.

California Natural Gasoline Association, fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif., Oct. 8-9.

National Electronics Conference, sponsored by Illinois Institute of Technology, two societies and two universities, Hotel Sherman, Chicago, Oct. 12-14.

NACE, south central region, Cosmopolitan Hotel, Denver, Oct. 12-15.

Gas Measurement Institute, National Guard Armory, Liberal, Kan., Oct. 13-14.

ASCE, pipe line division, annual meeting, Statler-Hilton Hotel, Washington, D. C., Oct. 19-23.

NACE, north central region, Statler-Hilton Hotel, Cleveland, Oct. 20-22.

ASME, ASLE, lubrication conference, Hotel Sheraton-McAlpin, New York City, October 20-22.

Society for Experimental Stress Analysis, annual meeting, Pick Fort Shelby Hotel, Detroit, Mich., Oct. 21-23.

Fifteenth Annual Conference on Industrial Hydraulics, Hotel Sherman, Chicago, October 22-23.

NGAA, southern regional meeting, Carlton Hotel, Tyler, Texas, Oct. 23.

INGAA, annual meeting, Westward Ho Hotel, Phoenix, Ariz., Oct. 26-27.

Independent Petroleum Association of America, annual meeting, Statler-Hilton Hotel, Dallas, October 26-27.

Computer Applications Symposium, Morrison Hotel, Chicago, October 28-29.

Institute of Radio Engineers, electron devices meeting, Shoreham Hotel, Washington, D.C., Oct. 29-30.

November

Radioisotope Technique Short Course, University of Oklahoma, Nov. 2-6.

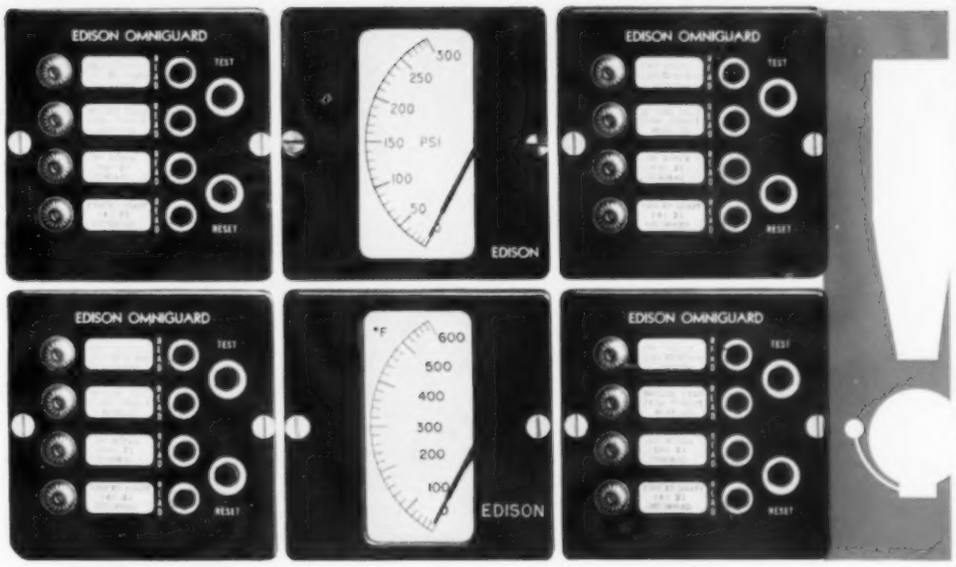
Rocky Mountain Oil & Gas Association, Fourteenth annual convention, Cosmopolitan Hotel, Denver, Nov. 4-6.

Institute of Radio Engineers, automatic control national conference, Sheraton Hotel, Dallas, November 4-6.

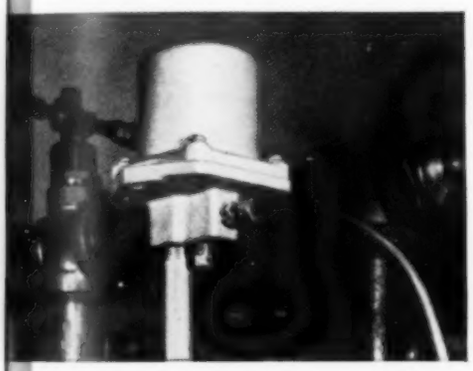
Institute of Radio Engineers, fourth instrumentation conference, Atlanta Biltmore Hotel, Atlanta, November 9-11.

API, 39th annual meeting, Conrad Hilton, Palmer House and Congress Hotels, Chicago, Nov. 9-11.

GUARD ALL CRITICAL PRESSURES AND TEMPERATURES WITH THOMAS A. EDISON LOW-COST, OMNIGUARD WARNING SYSTEM



Here is a versatile, highly-reliable continuous warning and monitoring system. By simply pushing a button on this panel you obtain a reading of *key pressure* and *temperature* points throughout your plant. In addition, this system provides instantaneous warning when pressure or temperature deviates from pre-set limits.

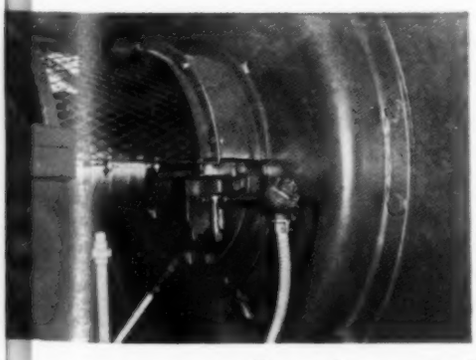


Compact, reliable Resistance Pressure Detector transmits changes in pressure to central control panel.

PRESSURE

With the Edison Omniguard system you can monitor gas, fluid or vapor pressure. Heart of the system is a rugged, accurate, pressure detector which converts pressure directly to electrical resistance—requires no millivolt conversion—no amplifier. For pressures under 60 PSI a precision capsule is the sensing element. From 60 to 3000 PSI special bourdon tube elements are used.

When pressure changes, resistance varies and this deviation is transmitted to the control panel. Units operate over ambient temperatures of 32° to 150° F. Control panels are available with a wide variety of scales and are equipped with both normally open and normally closed alarm contacts to operate any type of auxiliary device or to automatically shut down machinery or process.



Rugged, accurate Resistance Temperature Detector guards against overheating of this motor bearing.

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Edison Omniguard also provides reliable protection from overheating. You can monitor the temperature of bearings, gases and liquids in critical equipments or processes. Reliable Edison Resistance Temperature Detectors have no moving parts and give instantaneous warning when limits are exceeded. Unlike other systems which only scan, Omniguard is continuously monitoring. You can obtain exact readings of temperatures in all parts of your plant from one central control panel.

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NACE, Fourth annual general Florida conference short course, Key Biscayne Hotel, Miami, Fla., November 16-20.

Fifth International Automation Exposition, New York Trade Show Building, New York, November 16-20.

NGAA, Panhandle-Plains regional meeting, Herring Hotel, Amarillo, Texas, November 20.

ISA, Philadelphia section, symposium, Ben Franklin Hotel, Philadelphia, Nov. 23-24.

ASME, annual meeting, Chalfonte Haddon Hall, Atlantic City, Nov. 29-Dec. 4.

December

NACE, University of Illinois short course, Urbana Campus, December 7-11.

1960

January

NGAA, Gulf Coast regional meeting, Robert Driscoll Hotel, Corpus Christi, Jan. 22.

NACE, Corrosion control short course, University of Houston, Houston, Jan. 22-23.

Pipe Line Contractors Association, 12th annual meeting, Ambassador Hotel, Los Angeles, Jan. 31-Feb. 3.

February

Canadian Contractors Association, annual meeting, Empress Hotel, Victoria, B.C., Feb. 25-27.

March

NACE, 16th annual conference, Dallas Memorial Auditorium, Dallas, March 14-18.

Mid-West Gas Association, annual meeting, Hotel St. Paul, St. Paul, Minn., March 21-23.

New England Gas Association, annual meeting, Statler Hotel, Boston, March 24-25.

PIEA-PESA, Thirty-second annual petroleum industry conference and exhibition, Municipal Auditorium, Kansas City, Mo., April 12-15.

April

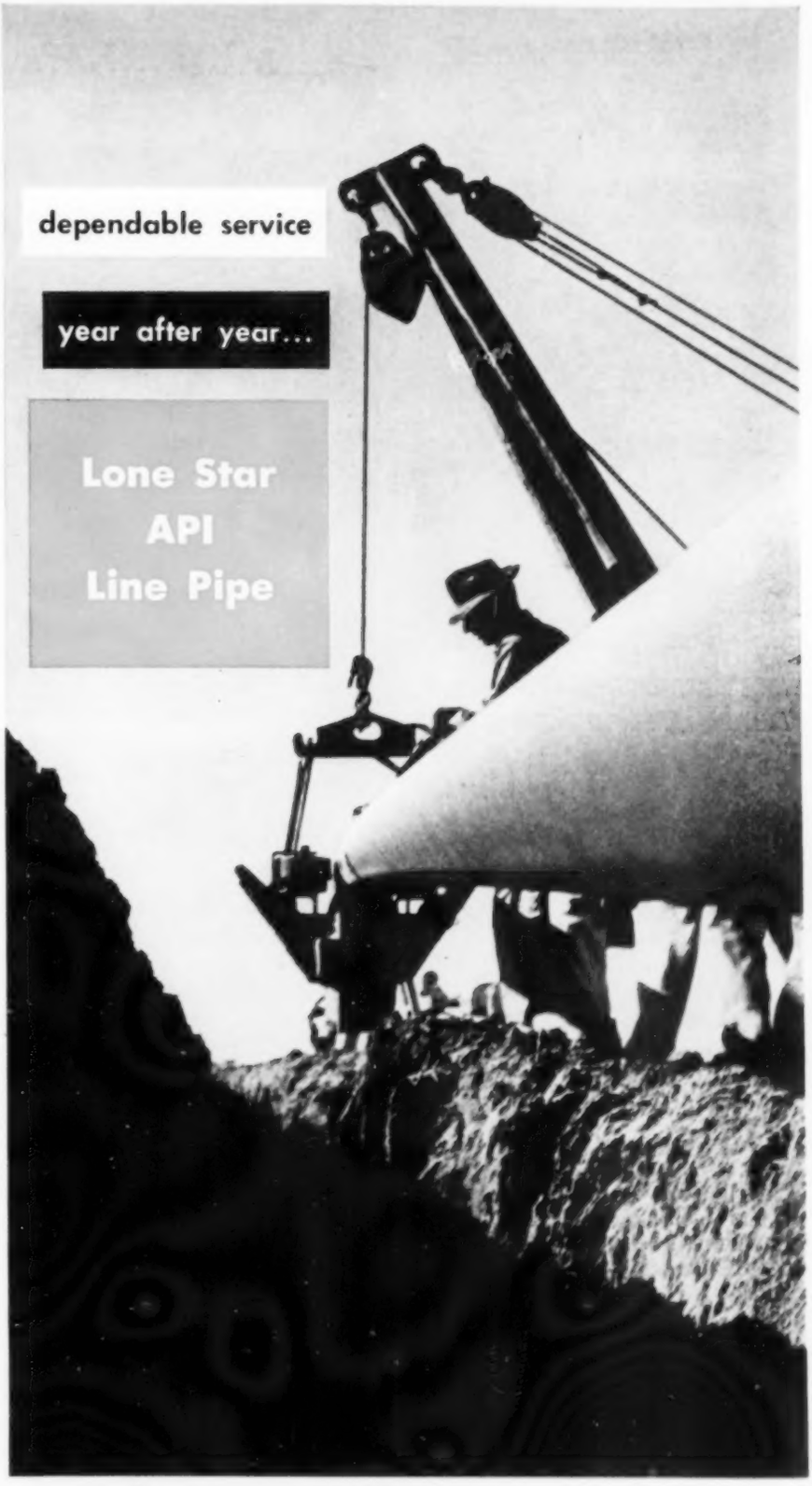
Southwestern Gas Measurement Short Course, Drill Hall, North Campus, University of Oklahoma, April 19-21.

Southern Gas Association, annual meeting, Galveston, Texas, April 25-27.

API, Division of Transportation, pipe line conference, Mayo Hotel, Tulsa, April 28-29.

May

AGA Operating Section, Joint distribution and transmission conference, Roosevelt and Jung Hotels, New Orleans, May 9-13.



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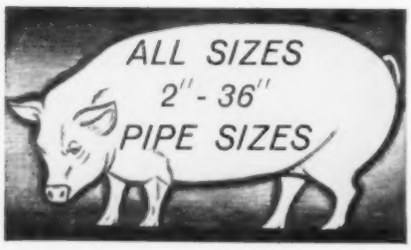
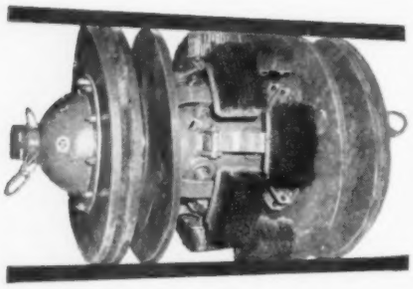


ANY COMBINATION ALWAYS IN STOCK



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What's Happening among SERVICE and SUPPLY MEN

Plicoflex, Incorporated Opens New Plant in Houston

Plicoflex, Incorporated, has placed its new plant in operation and moved its headquarters to Houston. Manufacturer of a polyinyl chloride-butyl rubber protective tape for pipe lines, the company moves to Houston from California where it was formed in 1953. The large plant has a yearly production capacity of 250 to 300 million square feet of tape.

F. H. Maloney Co. Names E. E. Eutsler President

F. H. Maloney Company named E. E. Eutsler president, replacing F. H. Maloney who becomes chairman of the board. H. B. Finch has been appointed secretary-treasurer succeeding Eutsler. James H. McBrien, general sales manager, and Finch were named members of the board.

E. E. Eutsler

Eutsler continues as general manager, and Finch is controller of the company. Maloney started the firm in 1932.

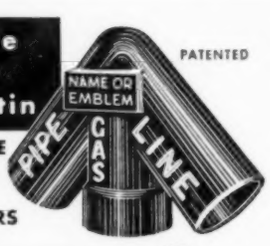
United States Steel Corp. Elects Pugsley Executive Vice President

John Pugsley has been elected executive vice president, accounting, for United States Steel Corporation. Pugsley succeeds George W. Rooney, who retired. Joining the company in 1929, Pugsley was named assistant to the auditor of National Tube Company, in 1938 and became assistant comptroller in 1939. In 1940 he was named comptroller of that division. Pugsley was appointed executive vice president of Tennessee Coal & Iron Division in 1951, and was promoted to assistant executive vice president-accounting of United States Steel Corporation in 1957. He was named administrative vice president-accounting in 1958.

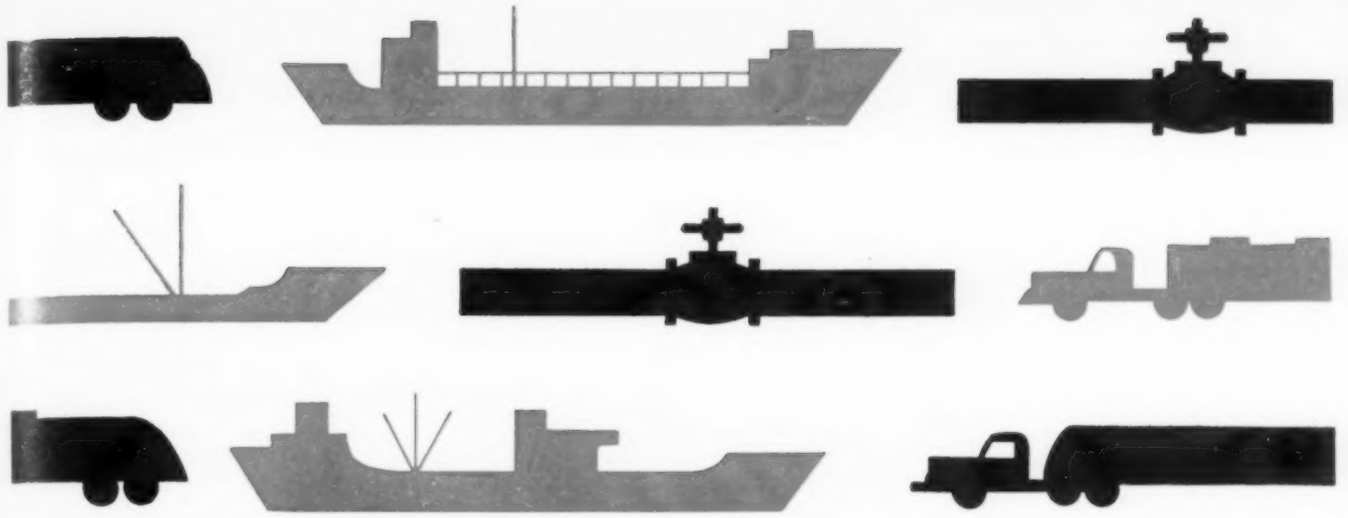
CAPACITY

SACHSE ELECTRIC INC.
BATON ROUGE LA.

Write for Bulletin
PIPELINE VENTS AND MARKERS

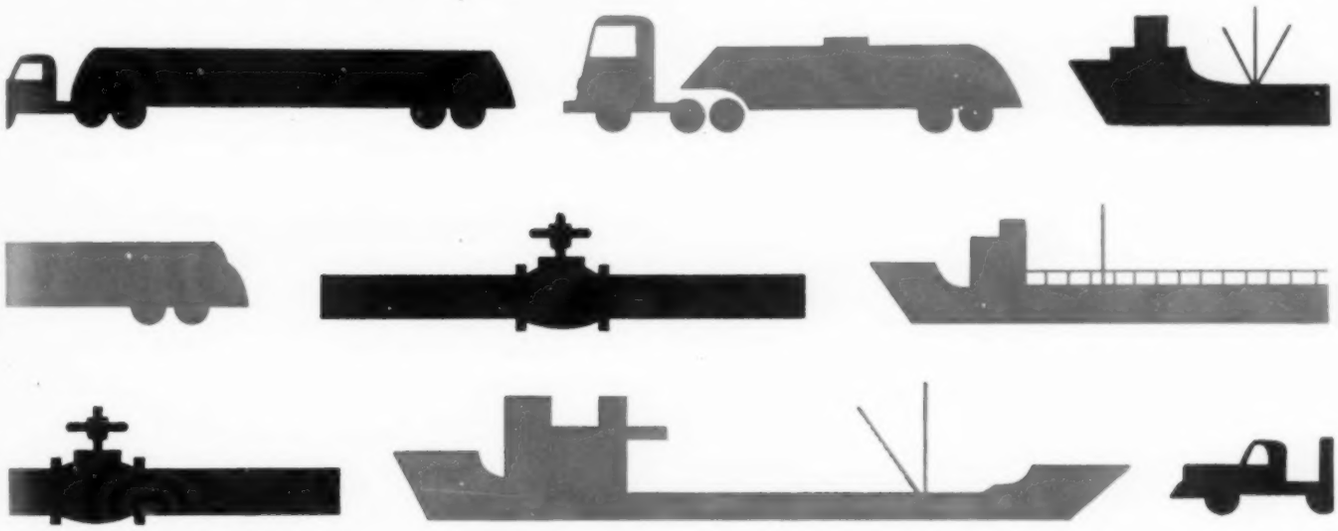


FLEET-LINE CO.
P. O. BOX 276-K
SHREVEPORT
LOUISIANA



FOR SAFE TRANSPORT-LAND AND SEA

SHAND AND JURS TANK FITTINGS



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Allis-Chalmers Manufacturing Co. Names Koob Public Affairs Director

Robert L. Koob has been named director of public affairs for Allis-Chalmers Manufacturing Company. Koob will act as a consultant on government affairs to all divisions of the company; his activities will emphasize the role of citizenship in local, state and national affairs. He had been director of the Division of Industrial and Port Development in former Governor Vernon Thomson's office in 1957-58.

Clark Bros. Co. Establishes Turbo Repair Shop in Beaumont

Designed to assist the users of Clark centrifugal compressors, Clark Bros. Co. has opened a turbo repair facility in Beaumont, Texas, at the Ideco, Inc., plant.

The operation is an extension of existing facilities for the packaging and final assembly of Clark field compressors. The Beaumont site was selected because of its proximity of high concentration of Clark's turbo machinery in the Southwest and Mexico. It is expected the main portion of work performed will consist of rotor repairing and rebuilding.

Harley Sales Co. Elects Bob R. Neal President

Bob R. Neal has been named president of the Harley Sales Co., distributor of Wisconsin Motor Corp. equipment. Neal, who succeeds his uncle, Roy Neal, has been with the company since 1948. He had been chief engineer and sales manager.

Bob R. Neal

Other Harley appointments include John O. Moore as sales engineer in Oklahoma, Kansas, and Texas, and Dick W. Johnson who was promoted to general sales manager. Moore had been with Worthington Corp., and Johnson has been with the company since 1952.

General Electric Names Pitman Manager of Product Planning

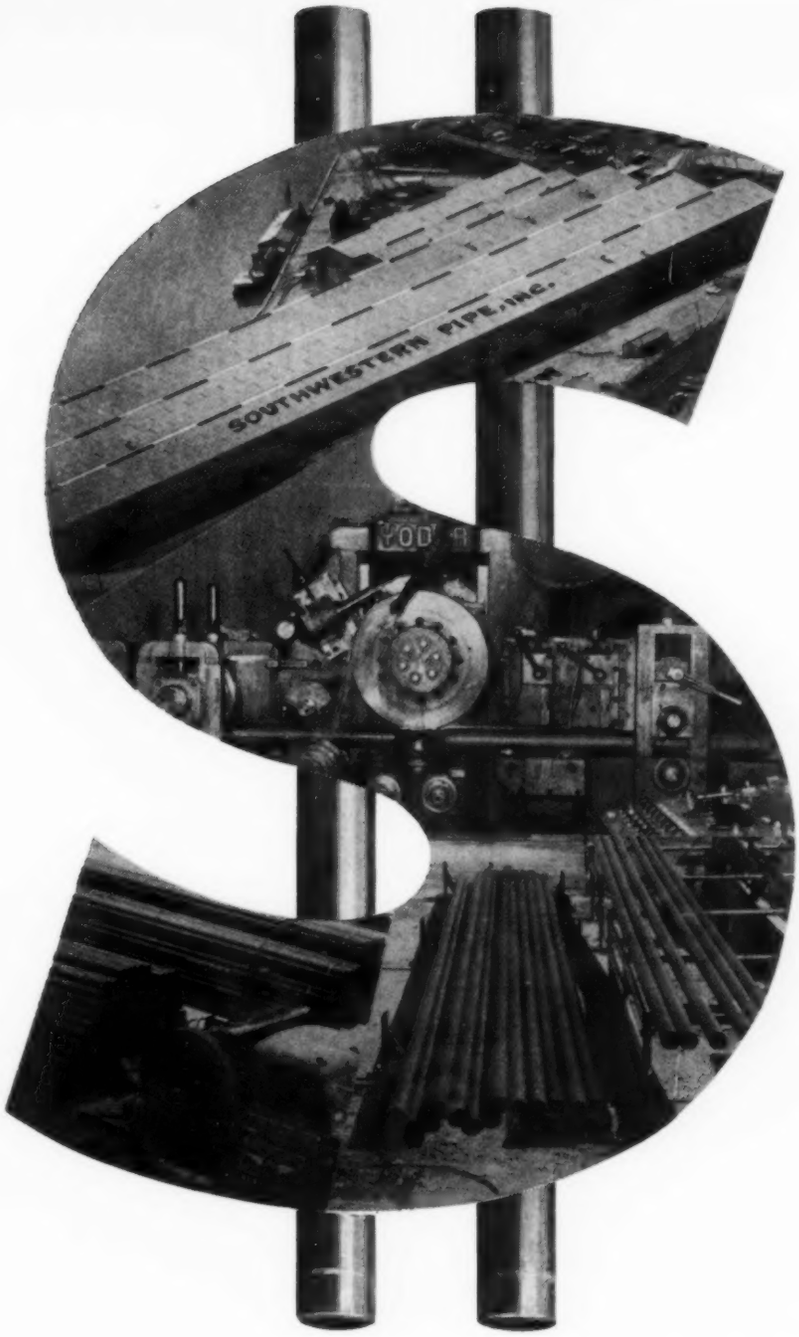
General Electric Communication Products Department has appointed James E. Pitman manager of product planning for point-to-point communication equipment.

He succeeds Kent J. Worthen who was named national sales manager for the company's two-way radio. Pitman is responsible for long-range development on microwave relay, power line carrier and terminal communications products.

Bendix-Pacific Division Acquires Rights to Manufacture, Sell Valves

Bendix-Pacific, Division of Bendix Aviation Corporation, has acquired the rights from Fluidal Valve, Inc., to manufacture and sell a hydraulic valve.

Newman, Hender & Co., Ltd., has been sublicensed by Bendix to produce and market the valve in the United Kingdom. The valve can be designed from half-inch to 36 inches and can be opened or closed in three-thousandths of a second.



LIGHTWALL . . . biggest value for your pipeline dollar

Southwestern LIGHTWALL Electric Resistance-Weld Line Pipe greatly reduces weight without sacrificing performance . . . delivers actual dollar savings four ways over standard-weight pipe. With Southwestern LIGHTWALL, every customer benefits from savings in initial cost, transportation, installation, and in longer life when given proper corrosion protection. Southwestern LIGHTWALL Electric Resistance-Weld Line Pipe is available in a wide range of wall thicknesses to .188" wall, from 1.315" O.D. to 4.500" O.D. Because of Southwestern's manufacturing flexibility and large inventories of selected steel coils, you can depend on prompt deliveries.

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SOUTHWESTERN PIPE, INC.*

Corporate name changed from Southern Sales & Transportation Co, May 1st, 1959

P. O. BOX 2002 HOUSTON 1, TEXAS PHONE CAPITOL 4-0631

B. B. Pettigrove

J. W. Rodgers

Allan Edwards, Inc., Announces Appointments in Sales Department

B. B. Pettigrove has been appointed general sales manager, and J. W. Rodgers is the new Dallas area district manager for Allan Edwards, Inc. Joe L. Creed has joined the sales staff.

Pettigrove has been with the firm five years; Rodgers joined the company in 1948.

Evans Elected Chairman; Clegg Named President for Crane Company

Thomas Evans has been named chairman of the board and chief executive officer of the Crane Co. Evans appointed L. H. T. Clegg, president of Crane's Canadian subsidiary, acting president of the parent firm filling the vacancy created by the resignation of Neele E. Stearns.

Other directors elected to the board include Alfons Landa, Robert B. Crane and E. A. Locke, Jr.

Briggs Filtration Company Names Kenneth B. Owings Project Engineer

Kenneth B. Owings has been named project engineer for Briggs Filtration Company. Owings has been with Tidewater Oil Company for the past 12 years; he handles field testing and development work on fuels and lubricants. He will be in charge of research and development of diesel and industrial lubricating oil filtration.

Grove-France, S.A., Formed As Walworth Company Corp.

Walworth Company has organized a French corporation, Grove-France, S.A., to manufacture and sell valves in France and French colonial possessions. The new company will be under direct management of Marvin H. Grove, president of Grove Valve and Regulator Co., subsidiary of Walworth.

Ken Kendall Joins Daniel Orifice In Los Angeles Sales Department

Ken Kendall has jointed Daniel Orifice Fitting Company sales force in Los Angeles. He had been sales engineer with Rockwell Manufacturing Company for five years.

ALCO Products, Inc., Completes Office, Warehouse at Houma, La.

ALCO Products, Inc., has completed an office and warehouse with testing and repair facilities at Houma, La. These new facilities will be directed by a newly-formed Louisiana corporation, ALCO Products Oilfield Equipment Company, Inc. C. P. Gillespie and W. L. Henderson, sales representatives, will be in charge of the new Louisiana office.

Included in the expansion are steam cleaning equipment and two test racks with test capacity of 30,000 psi.

Burndy Corporation Appoints Lyons Production Manager

Lawrence M. Lyons has been named production manager of the Utility Industrial division of Burndy Corporation.

He will supervise all manufacturing at the division's plants in New York City and Connecticut. Lyons has been with the company since 1940.

Thomas G. Sanders Joints Youngstown Sheet and Tube

Youngstown Sheet and Tube Company announces the appointment of Thomas G. Sanders as market research analyst in the Commercial Research Department.

He comes to Youngstown from U. S. Steel where he served as product analyst. Presently he is working toward his masters degree in economics at Georgetown University.

W-K-M Executive Posts Filled By R. O. Wynn and H. C. Tooley

Robert O. Wynn has been chosen as president of engineering and research and Henry C. Tooley was named vice president of manufacturing for W-K-M Division of ACF Industries, Inc.

Wynn, vice president of manufacturing for W-K-M since 1956, for the past six years had been head of the Engineering Department. Tooley joined the company this year as manager of the Missouri City, Texas, plant. He had been vice president of Reed Roller Bit Company.

Glamorgan Pipe & Foundry Co. Builds Pipe Extrusion Plant

A rigid polyvinyl chloride pipe extrusion plant, known as Plastic Division, has been added to Glamorgan Pipe & Foundry Company facilities.

Located at Lynchburg, Va., the plant will be headed by Armistead Long, Jr.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF PIPE LINE INDUSTRY, published monthly at Houston, Texas, for October, 1959.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Wm. G. Dudley, 4742 Banning, Houston, Texas; Editor, Melvin A. Judah, 806 North Rice Avenue, Bellaire, Texas; Managing Editor, Wallace Fitzgerald, 5423 Lymbar, Houston, Texas; Business Manager, Robert M. de Sombre, 4410 Ingersoll, Houston, Texas.

2. The owner is: The Gulf Publishing Company, Houston, Texas; June Wooden Bliss, Houston, Texas; Juis Wooden Dudley Bliss—Trustee, Houston, Texas; Mrs. Grace C. Carter, Dallas, Texas; Mrs. Margaret D. Cashman, Beaumont, Texas; Drum & Company, c/o Trust Department, Houston, Texas; P. Stinson Dudley, Abilene, Texas; Ray L. Dudley (Deceased), Houston, Texas; Wm. G. Dudley, Houston, Texas; Wm. V. Gross, Austin, Texas; Mrs. Carolyn Dodson Keeble, Abilene, Texas; Mrs. Anita S. Lane, Houston, Texas; Charles H. Lane, Houston, Texas; James William Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; Mrs. Sallie Windham Rieder, Houston, Texas; Walter Gage Sterling—Trustee, Houston, Texas; O. R. Waller, Chicago, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are NONE.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

R. M. de SOMBRE
Business Manager

Sworn to and subscribed before me this 16th day of September, 1959.

P. J. AUCOIN
(Seal) Notary Public in and for Harris County, Texas
(My commission expires June 1, 1961)

CLASSIFIED ADVERTISING

BARGAINS!

28 Walworth 8" Gate Valves—Model 841-F. These valves are new and in perfect condition. Price $125.00 each.

1 Worthington Steam Driven Reciprocating Pump, 5¼ x 3½ x 5. The pump is new and in perfect condition—$200.00.

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SALESMAN WANTED

Well-established successful firm has opening in an expanding sales department for young man looking for an opportunity in sales work. Must be college graduate, not over 33, in good health, ambitious and not afraid of work. Oil industry experience desirable. The man we are looking for will be trained at home office before moving into sales work on basis of salary plus commission incentive and traveling expenses. Our own personnel know of this advertisement. Your reply will be confidential and should be sufficiently complete to merit contacting you for an interview. Address Box 56-P, PIPE LINE INDUSTRY, Houston, Texas.

PETROLEUM EQUIPMENT DIVISION of A. B. Chance Company has opening for man with pipe line construction experience. We need someone to handle the application engineering and installation supervision of Chance anchors. Job headquarters in Dallas, Texas. Travel involved. This is excellent opportunity for man between 27 and 40 with pipe line design or construction experience who is looking for real growth opportunity. Salary open. Outstanding employee benefits include yearly bonus, profit sharing, merit increases, and major medical insurance program. Replies confidential. Send resume including age, education, experience to: **A. E. Cassling, A. B. Chance Company, Centralia, Missouri.**

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MERCURY
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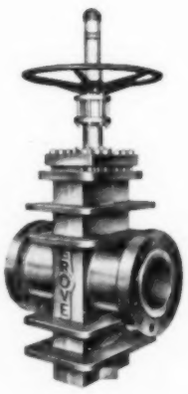
MECHANICAL ENGINEER having extensive experience in design, operation and maintenance of crude or products pipelines, pumping stations, terminals and loading facilities. Thoroughly familiar with selection and operation of all equipment used in these facilities. Five years minimum experience. Graduate. Locate in Tulsa with intermittent worldwide travel. Please do not apply unless have specific experience noted above. All replies confidential. Write fully to: Box 55-P, **PIPE LINE INDUSTRY, Houston, Texas.**

Strapped with a barrel of trouble?

GROVE valves never require lubrication



Get rid of the load of lubrication with Grove Seal-O-Ring gate valves. Save the countless man hours, expensive supplies and equipment required to maintain ordinary valves. Grove valves work without lubricant or sealing compound. Tough, resilient Hycar "O" rings—in the valve seats—wipe the gate face clean of foreign matter which might cause sticking or distortion...seal bubble tight on both sides of the gate... There's no fear of valve failure because of forgotten lubricant or depleted sealing compound. And you eliminate the danger of contamination or meter fouling resulting from lubricant or sealing compound entering the line.

Unload your troubles...Specify Grove Seal-O-Ring gate valves...for pipeline or production services.

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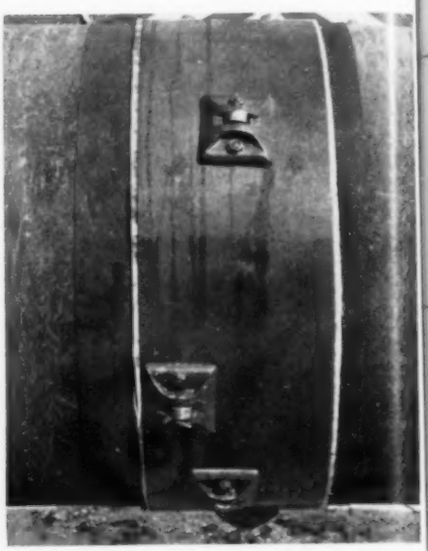
6439

For more data on advertised products, use Readers' Service Cards, last page.

What's New in EQUIPMENT

To receive more information on all new equipment articles use Readers' Service Card, last page of this issue.



Roller-bearing casing insulators on left are used on 10-inch pipe which is shoved into 12-inch spiral-weld casing. At right is a close-up of an insulator for 24-inch pipe. Three rollers are staggered on each side of the insulator.

Roller-Bearing Casing Insulators Introduced

A roller-bearing casing insulator, designed to speed construction work on road crossings, has been introduced by Greenhead Sling and Supply Company.

The insulator consists of: a one-piece steel band with rollers fastened to the pipe with a bolt-clamp; a specially fabricated mastic insulation between pipe and steel band; non-conductive plastic bearing housings; and 4 to 6 rollers staggered in a pattern to permit the pipe to "walk" over obstructions such as girth welds.

Four 1-inch I.D. by ½-inch wide rollers are used on insulators for small diameter pipe; six rollers are used for large diameter casings. The roller-insulators can be made for any size pipe.

The insulation wrap, strengthened with a fiber-filler to prevent cold flow, is made with a minimum thickness of ⅛-inch.

During a recent field test, three 24-inch insulators supported a 4,000-pound, 42-foot joint which was rolled into a 30-inch casing. Insulators normally are spaced at 10-foot centers.

Insulators are designed to allow smoother movement of the carrier pipe as it is inserted into the casing and thereby preventing possible damage to coating of the pipe.

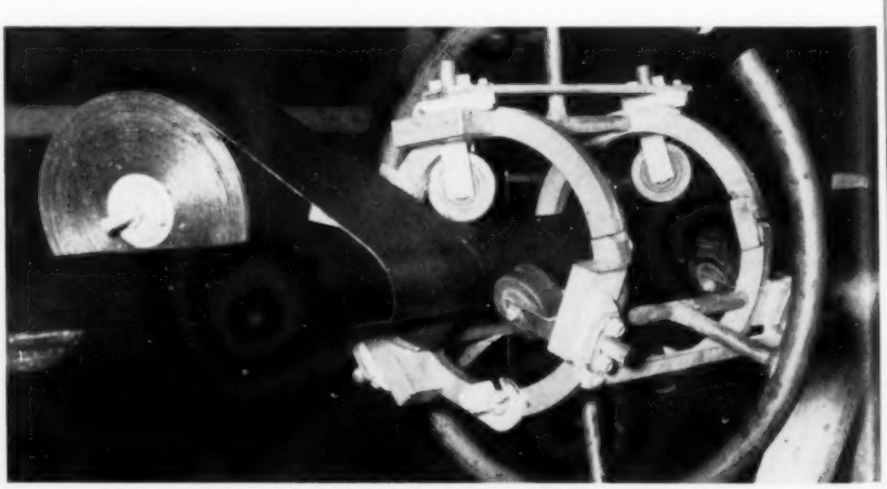
(This item supplements Greenhead Sling and Supply Company data on page 203 of the Pipe Line Catalog, Second Revision).

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Polyvinyl-Butyl Tape

Combining butyl rubber and polyvinyl chloride, Plicoflex, Incorporated, has developed a new pipe line protective tape. The butyl-vinyl tape is applied over a rubber base primer which provides a tighter bond for the tape.

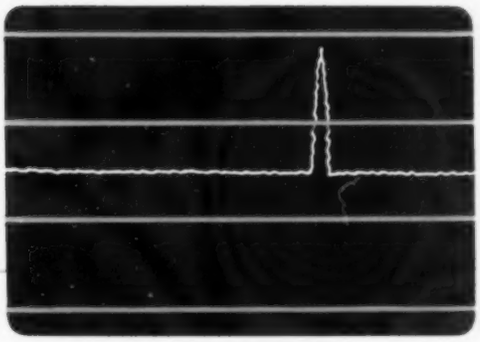
The tape is manufactured in a two-step process. First, the vinyl is compounded, calendered and rolled into sheet form. Then the butyl rubber is calendered and laminated to the vinyl by a process involving heat, pressure and an additive. The polyvinyl forms the outside of the tape and the butyl makes up the inside layer. Tape is applied with the butyl side against the primed surface. The rubber affords a flexible tape which "flows" into crevices and scratches to eliminate gaps between pipe and tape. Vinyl outer layer provides strength, toughness, and abrasion resistance as well as permanence to the tape. The vinyl contains flame proofing and fungicidal chemicals.



The tape varies in width from 1- to 18-inches and in thickness from 15- to 35-mils. The amount of butyl and vinyl in each size is: 15 mils, 7 vinyls and 8 butyl; 20 mils, 7 vinyl and 13 butyl; 25 mils, 10 vinyl and 15 butyl; 30 mils, 15 vinyl and 15 butyl; and 35 mils, 20 vinyl and 15 butyl. The product is available in 10 colors.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

The Reflectoscope . . .



ANOTHER SAFEGUARD TO QUALITY IN

Acme-Newport ELECTRIC WELD LINE PIPE

The penetrating electronic eye of Reflectoscope is the latest of many safeguards to the quality of Acme-Newport line pipe. By scanning miles of pipe for possible defects not visible to the human eye, this unique device affords still another check of a score of processes that go before. Acme-Newport combines the most modern facilities and methods with 75 years of steel-making success, to become a most logical source for your electric weld line pipe, 4″ and 6″ sizes, standard or thin wall. For easy installation and long, uninterrupted service, make Acme-Newport your next buy.

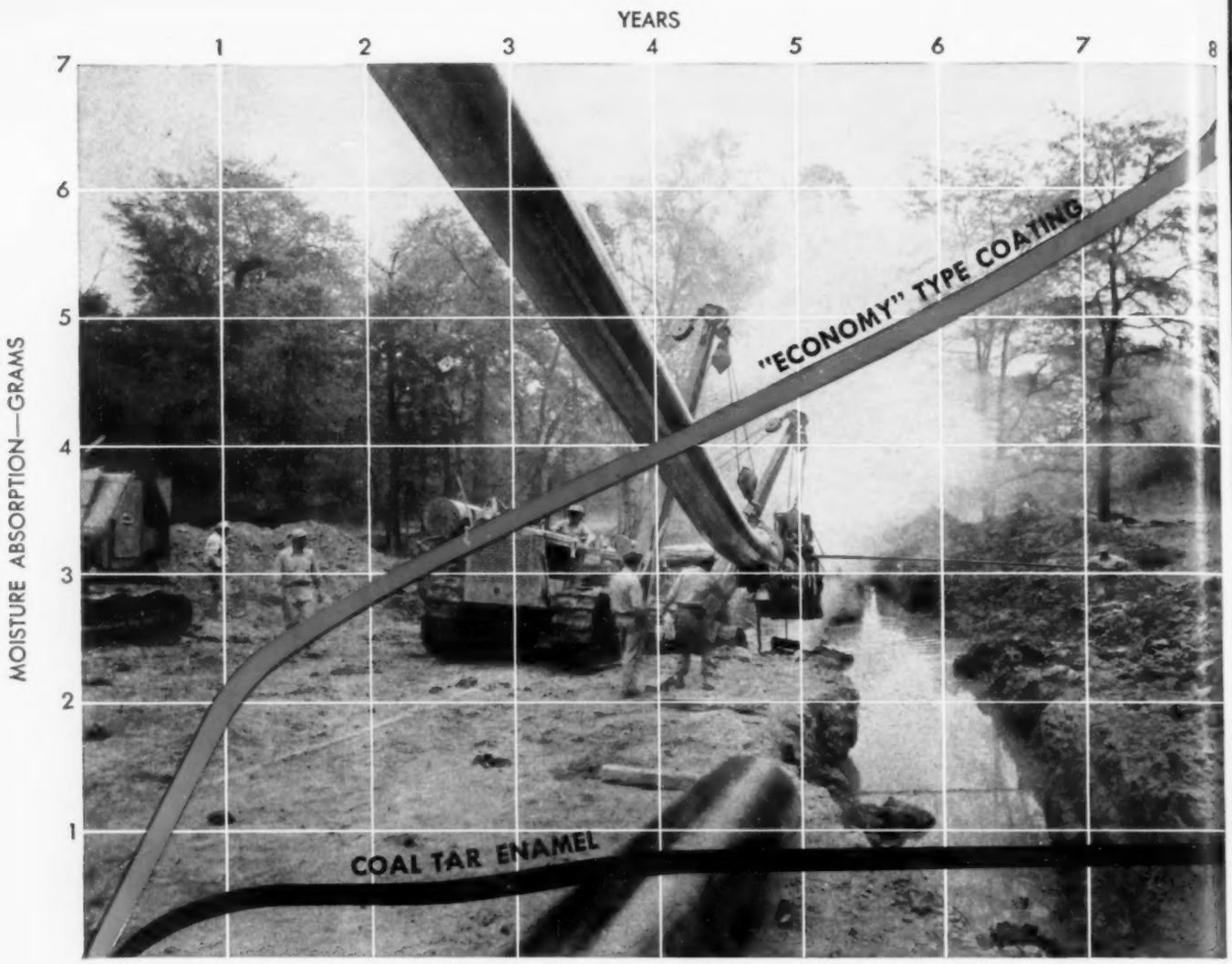
SIZES AND WEIGHTS AVAILABLE

O.D.	Wall	Wt. Per Ft.
4½	.125″	5.84
	.142″	6.61
	.156″	7.25
	.188″	8.64
	.219″	10.00
	.237″	10.79
6⅝	.156″	10.78
	.188″	12.89
	.219″	14.97
	.250″	17.02
	.280″	18.97

Acme-Newport Steel COMPANY

NEWPORT, KENTUCKY

A SUBSIDIARY OF ACME STEEL COMPANY



This Moisture Absorption Comparison Shows Why Most Pipelines are Protected with COAL TAR ENAMELS!

THE chart above, prepared by an independent pipeline engineer*, shows why an overwhelming majority of pipeline owners and operators select *coal tar enamels* to protect their underground investment. No other coating material can *begin* to match the ability of coal tar enamel to resist moisture absorption.

Field tests show that an "economy type" coating exhibits a constant moisture absorption increase. The continuously increasing cost of cathodic protection soon eats up any first-cost savings in material. Peeling and deterioration eventually require expensive reconditioning.

So why risk the chance of costly failures with an "economy" coating or other protection methods not *proved by time?* Specify PITT CHEM Coal Tar Coatings and be *sure* of economical, long-lasting protection.

PITT CHEM maintains a full-time staff of field service men to work with your field men in the efficient application of pipeline enamels. *Write us about your protection requirements . . . today!*

**Name upon request*

★ PITT CHEM® Coal Tar Pipeline Enamels
★ PITT CHEM "Insul-Mastic"® Gilsonite-Asphalt Coatings
★ PITT CHEM "Tarset"® Coal Tar-Epoxy Resin Coatings
★ PITT CHEM "Tarmastic"® Coal Tar Coatings

PROTECTIVE COATINGS • COAL CHEMICALS • PLASTICIZERS • ACTIVATED CARBON • CEMENT • COKE • PIG IRON • FERROMANGANESE

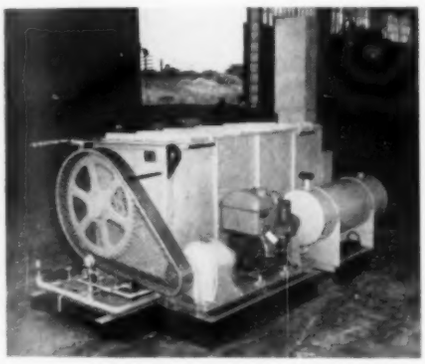
Small Side Boomers

Midwestern Manufacturing Company's "little boomer" is now available for mounting on Ford series 1,800 industrial wheel tractors.

Especially adaptable to work in urban areas, the sideboom has a lifting capacity of 5,000 pounds. The rubber-tired tractors eliminate danger of damaging city streets; tractors are equipped with power steering for ease of handling. The sideboom features simplified, all-hydraulic controls.

(This item supplements Midwestern Manufacturing Company data on Page 292 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E3** on Readers' Service Card, last page this issue.



Weight Coating Pug Mill

A pug mill for heating asphalt mastic weight coating for coating field joints has been introduced by Avondale Marine Ways, Inc. The complete pugmill is skid mounted. In the mixer, the heavy coating is kept in constant motion by the rotation of 12 steel paddle arms and blades.

The mixing blades are driven by a 10 hp diesel engine which also powers a blower, furnishing compressed air for the burner system. Capacity is about 150 pounds per minute from ambient temperature up to 450°.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

Tractor Shovel

Allis-Chalmers Manufacturing Company announces a new tractor shovel. The 1½-cubic yard HD-6G unit is powered by a 4-cycle diesel engine rated at 72 hp. Four forward speeds from 1.5 to 5.5 mph and two reverse speeds of 2.0 and 4.1 mph may be selected with the single lever shift located within reach of operator.

(This item supplements Allis-Chalmers data on Pages 41-44 of Pipe Line Catalog, Second Revision.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

NOW ***from PARSONS . . . a complete line of WHEEL Trenchliners to fit any job***

Big things have happened since you last looked at wheel-type trenchers. Today, you'll find the *right answer* to your job . . . the *right size* wheel machine for lowest cost per lineal foot of trench, in the big, well-rounded Parsons® line. There's extra capacity, performance and dependability in every size. Check the chart below . . . pick the Trenchliner® that best suits your requirements . . . then contact Parsons distributor for a demonstration. See him soon . . . or mail coupon for more information.

MODEL	TRENCH WIDTHS	MAX. DEPTH	DIGGING SPEEDS
130	12 to 24 in.	5¾ ft.	12 in. to 18 ft. per min.
150	16 to 26 in.	5¾ ft.	12 in. to 25 ft. per min.
170	20 to 32 in.	5¾ ft.	12 in. to 25 ft. per min.
420	36 to 52 in.	7½ ft.	15 in. to 25 ft. per min.
520	40 to 52 in.	8½ ft.	12 in. to 28 ft. per min.

Also: 5 ladder-types for digging 6 INCHES to 6 FEET wide . . . up to 19 FEET deep

mail to: PARSONS Company, NEWTON, IOWA

Send literature on: ☐ 130 ☐ 150 ☐ 170 ☐ 420 ☐ 520 Trenchliner

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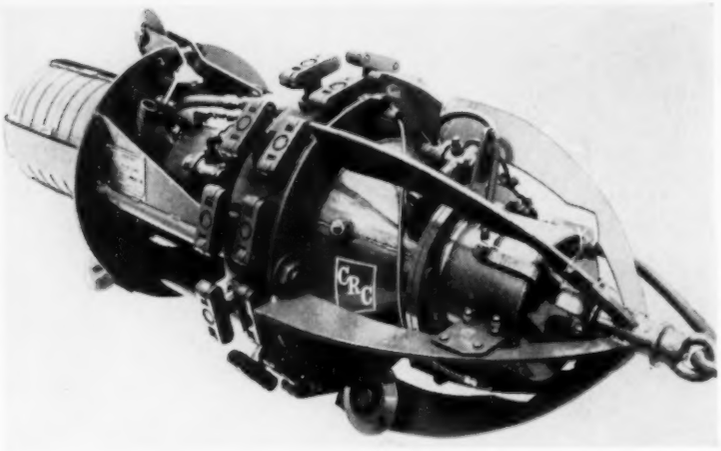
☐ Also interested in ladder-type Trenchliners PS23 P1

PARSONS Company • NEWTON, IOWA

A DIVISION OF KOEHRING COMPANY



Pneumatic Line-up Clamp

An air-operated line-up clamp, with rollers which roll pipe into perfect round without friction or sliding of clamp on pipe surface, has been introduced by Crutcher-Rolfs-Cummings, Inc.

Designed for pipe from 20- to 36-inch, the clamp features pneumatically-controlled heads which operate independently for quick line-up. The back head of the clamp can be locked into position, preventing the clamp from rolling back into the pipe.

(This item supplements Crutcher-Rolfs-Cummings, Inc. data on Pages 139-142 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

Pipelayer

Caterpillar Tractor Company has announced a new 572 Series D pipelayer with increased working ability and durability. The addition of a turbocharger increases flywheel horsepower to 140 and engine torque rise has been increased 80 percent. Lifetime lubricated track rollers, carrier rollers and idlers are standard on the No. 572.

Winch speeds have been increased. New line speeds are: first gear, 106 FPM; second gear, 214 FPM, and third gear, 513 FPM. Lowering speed has been increased from 222 FPM to 230.

(This item supplements Caterpillar Tractor Co. data on Pages 76-79 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

Portable X-Ray

Portable, lightweight X-ray equipment for inspection of pipe line sections and "window welds" has been introduced by General Electric Company. For inspection of such welds, as shown in photograph, this small machine handles the job without complications. The LX-140 unit weighs only 46¼ pounds and the control unit weighs 25 pounds. Both ship in a shockproof case.

A continuous range of 70 to 140 kvp is available. The unit operates in temperatures from 0 to 120° F, humidity up to 95 percent and altitudes up to 5,000 feet.

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

GOT THIS CATALOG ?
CHEMICAL FEEDERS by Manzel
MANZEL
Here's the most complete, most useful catalog on metering pumps ever published. Lets you select the exact unit you need to meet any requirement. Ask your Manzel field engineer . . . or write direct for YOUR FREE COPY.
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Specialists in metering pumps and lubricators since 1898

DESTINATION: TOMORROW!
WHEN OUR FIRST MANNED ROCKET SHIPS EQUIP FOR TAKE OFF TIR SILICONE AND SEMI-CIRCLE SPRING ELECTRODES WILL BE A MUST.
THE SE/1 IS A SPECIALLY DEVELOPED ELECTRICALLY CONDUCTIVE, FLEXIBLE, SPECIALLY MOULDED AND COMPOUNDED SILICONE RUBBER ELECTRODE FOR USE WITH ANY HIGH VOLTAGE HOLIDAY DETECTOR UNIT.
THE HCE S SERIES IS A NEW SEMI-CIRCLE ROLLING SPRING ELECTRODE WHICH GREATLY SPEEDS PIPELINE TESTING. THIS PRECISION MADE INSPECTION TOOL WILL APPLY HIGH VOLTAGE TO THE SURFACE OF ANY PIPE FOR DETECTION OF HOLIDAYS, BURNED, COKED OR THIN SPOTS IN THE PIPE COATING.
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Remco Manufacturing Co., Inc. Tulsa, Oklahoma
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Bob Herrick Rentals & Service Harrisburg, Penna.
Falcon Line Products Corp. Elizabeth, N.J.
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Electronic Detectors for every Industry
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417 AGOSTINO ROAD, P. O. BOX 281, SAN GABRIEL CALIFORNIA

THE PROPER WIND IN SPIRAL-WOUND

It's the precise control of gasket densities for every stage in the pressure series that makes each Flexitallic Gasket right for a given flange.

Flexitallic Spiral-Wound Gaskets are engineered to meet extreme conditions encountered in keeping with the pressure/temperature rating for the specified assembly.

These controls mean that a Flexitallic Gasket, designed for an extreme pressure/temperature rating, is never so soft that it crushes under the specified load, and never so hard that it resists the compression necessary for a specified seal.

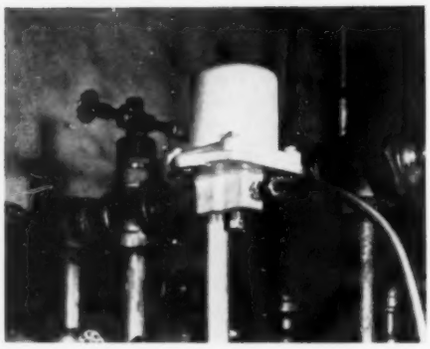
For predictable performance throughout all pressure/temperature ratings, look for Flexitallic Blue, the blue dye in the Canadian asbestos filler. It identifies the original Spiral-Wound Gasket construction.

FLEXITALLIC GASKET CO.
8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered tradename. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.



Pressure Detectors

A resistance pressure detector to measure gas, fluid or vapor pressures, in combination with the Omniguard monitor, has been introduced by Instrument Division of Thomas A. Edison Industries.

A wide variety of ranges is available for measurement of low pressures, measured in inches of mercury, to pressures of 3,000 psi. Each alarm pressure can be changed at any time by means of a simple screwdriver adjustment on the front of the monitor. For pressures under 30 psi, a precision capsule is the sensing element. From 30 to 3,000 psi, special Bourdon tube elements are used.

(This item supplements Instrument Division, Thomas A. Edison Industries data on Pages 165-166 of the Pipe Line Catalog, Second Revision.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

PROVED BY MILES & MILES & MILES &

now . . . longer life, improved performance for pipelines, crude units . . . with Unicor

Are you aware of the tremendous difference a small amount of Unicor can make in pipelines and crude units?

This film-forming, oil-soluble inhibitor prevents all kinds of corrosion. Wherever Unicor has plated out on a surface, it gives protection to tanks, vessels and pipelines whether full, part-full or empty.

By adding a small amount of Unicor to your product—10-20 parts to a million—you prevent product contamination, profit-robbing corrosion; assure maintenance of full-flow capacity and output.

Furthermore, use of Unicor substantially reduces filter cleaning and replacements, scraping operations, power costs and expensive downtime.

What Unicor does for tanks and pipelines it also accomplishes in crude units and other refinery equipment. For detailed information, write to our Products Department.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY

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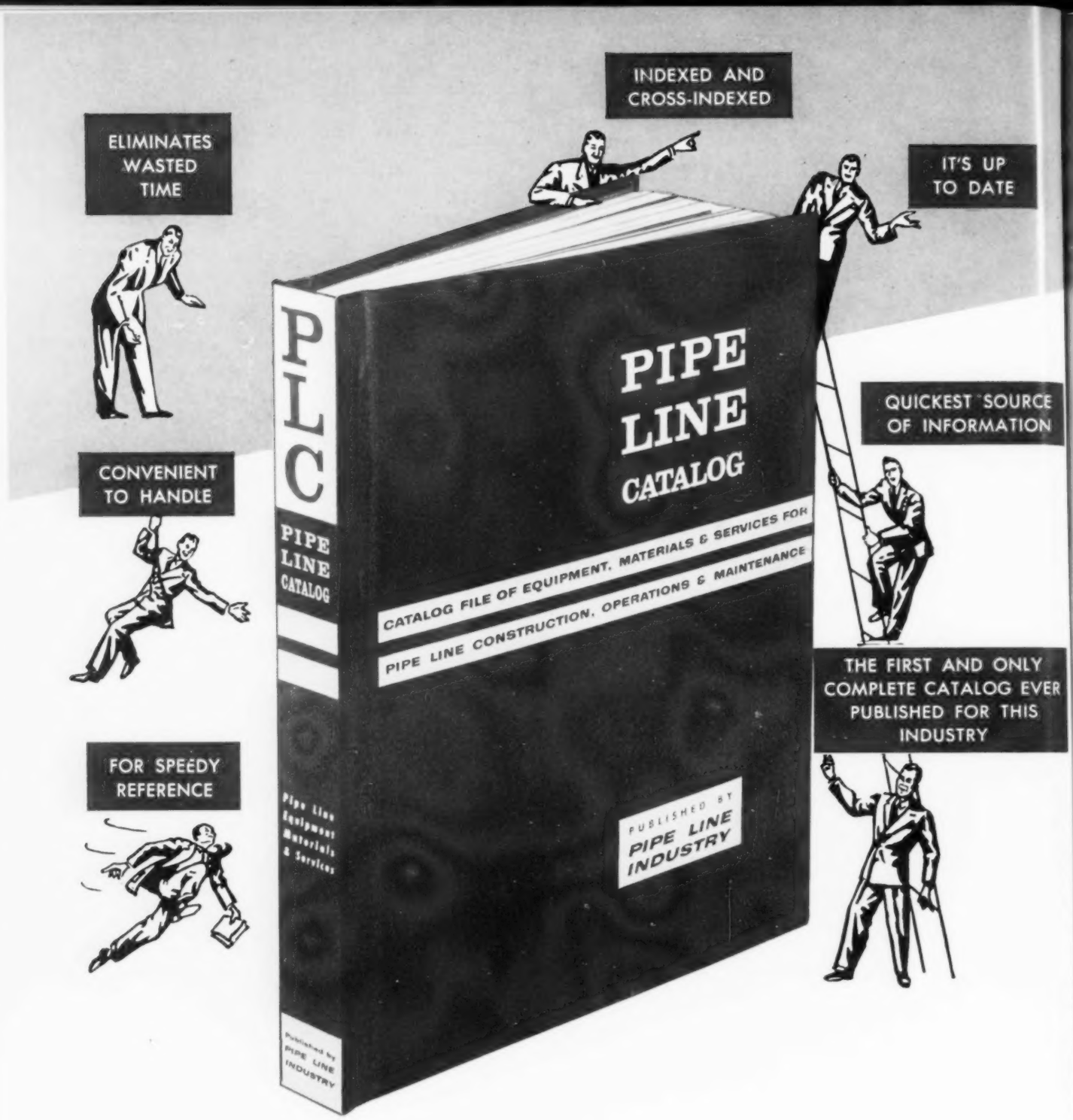
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ELIMINATES WASTED TIME
IT'S UP TO DATE
QUICKEST SOURCE OF INFORMATION
CONVENIENT TO HANDLE
FOR SPEEDY REFERENCE
THE FIRST AND ONLY COMPLETE CATALOG EVER PUBLISHED FOR THIS INDUSTRY
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PIPE LINE CATALOG
PIPE LINE CATALOG
CATALOG FILE OF EQUIPMENT, MATERIALS & SERVICES FOR
PIPE LINE CONSTRUCTION, OPERATIONS & MAINTENANCE
PUBLISHED BY
PIPE LINE INDUSTRY

The only catalog data file being published especially for the Pipe Line Business is a real success. It is serving as a genuine time saver for operating and field executives, superintendents, foremen, engineers, purchasing agents and many others who buy or specify equipment and materials.

More than 165 leading companies have filed their complete or condensed catalogs in this useful volume. Compiled by the manufacturers themselves, this information is arranged and indexed to offer a quick and convenient means of locating *what you want when you want it.*

If furnished to you in individual brochures, bulletins or specification sheets, the information that is now condensed into this composite catalog file would fill the equivalent of several file drawers or book shelves.

On the opposite page you'll find a complete list of the companies that have filed data in the specialized Pipe Line Catalog. When you are looking for sales information, be sure to check these companies in your Pipe Line Catalog. It is the most complete source of buying information available in one volume for this industry today.

ACF Industries, Inc., W-K-M Div.
Aeroquip Corp.
Aitken, M. N. Company
Aldrich Pump Co.
Allied Chemical, Plastics & Coal Chemical Division
Allis-Chalmers Mfg. Co.
Alston Mfg. Co.
American Blower Division American-Standard
American Cable Div. American Chain & Cable Co., Inc.
American Chain & Cable Co., Inc. R-P & C Valve Div.
American Cyanamid Co. Jefferson Chemical Co. Inc. Subsidiary
American-Marietta Co.
American-Standard, American Blower Division Norwood Controls Unit Detroit Controls
Anchor-Wate
Anderson, V. D. Co.
Andrews Tower, Inc.
Automatic Power Inc.

Barber-Greene
Beaird J. B. Co. Inc.
Bethlehem Steel Co. Supply Div.
Bettis Corp.
Bonney Forge & Tool Works
Borg-Warner Corp., Byron Jackson Div.
Bucyrus-Erie Co.
Buffalo-Eclipse Corp., Penberthy Mfg. Co. Div.
Byron Jackson Pumps Inc. Subsidiary of Borg-Warner Corp.

Carver-Stimpson Pipe Cleaning Co. Inc.
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Crane Co.
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Darling Valve & Mfg. Co.
Day, S. D. Co.
Dresser Industries, Clark Bros. Co. Div. Magnet Cove Barium Corp. Div.
Duff-Norton Co., Coffing Hoist Div.
Dunlap Mfg. Co.
Duriron Co. Inc.
Dutch Brand Div., Johns-Manville Corp.

Edison, Thomas A. Industries, Instrument Division
Allan Edwards, Inc.
Elliott Co., Ridgway Division
Elsey Mfg. Co.
Ensign-Bickford Co.

Fall Corp.
Farrel-Birmingham Co., Inc.
Flexitallic Gasket Co.
Fluor Products Co.
Fram Corp., Warner Lewis Co. Div.

These leading manufacturers, suppliers and service companies have filed complete or condensed catalog data in the current edition of the new PIPE LINE CATALOG. See their detailed information in the catalog when you are ready to buy.

Gardner-Denver Co.
Garrett Oil Tools, Inc., Division of U. S. Industries, Inc.
Gaso Pump & Burner Mfg. Co.
Gasoline Plant Construction Corp.
Gearench Mfg. Co.
General Descaling Co., Ltd.
General Electric Co., Apparatus Division
Gorman-Rupp Co.
Greenhead Sling & Supply Co.
Greenwood Valve Division Vernon Tool Co., Ltd.
Grove Valve & Regulator Co.

H & M Pipe Beveling Machine Co.
Hamer Valves, Inc.
Hercules Motors Corp.
Homelite, Division of Textron Inc.
Horton Equipment Co.
Hudson Engineering Corp.
Humble Oil & Refining Co.
Hydril Co.

Indus Corp.
Ingersoll-Rand
Instruments, Inc.

Jefferson Chemical Co., Subsidiary of American Cyanamid Co.
Johns-Manville Corp., Dutch Brand Div.

Kellogg, Communications Division of ITT
Kinzbach Tool Co., Inc.
Knudsen, Vic Co.

L & M Company
Ladish Company
Ledeen Mfg. Co.
Leland Equipment Co.
Lewis, Warner Co. Div. of Fram Corp.
Lloyd Metal Foundry

Magnet Cove Barium Corp. One of The Dresser Industries
Magnetrol, Inc.
Mallay Tool Service
Maloney, F. H. Co.
MAREP, S. N.
Marsh Instrument Co.
Mason-Neilan Div. of Worthington Corp.
Mathey, C. A. Machine Works, Inc.
Mavor-Kelly Company
McCord Corp.
McFarland Engineering & Pump Co.
McFarland Mfg. Corp.
McKissick Products Corp.
Mercoid Corp.
Midwestern Manufacturing Co.
Midwestern Pipe Line Products Co.
Mine Safety Appliances Co.
Mixing Equipment Co., Inc.
Morris-Young-Owens Co.
Murphy, Frank W. Mfr. Inc.

National Tank Co.
Naylor Pipe Co.
Nickles Machine Corp.
Norwood Controls Unit, Detroit Controls Division of American-Standard

Oil Well Supply Div. of U. S. Steel

Peerless Mfg. Co.
Pelican Supply Co., Inc.
Penberthy Mfg. Co., Division of Buffalo-Eclipse Corp.
Perrault Equipment Co.
Petrolite Corp., Tretolite Co. Div.
Philco Corp., Government & Indus. Div.
Philip Carey Mfg. Co.
Pipe Line Development Co.
Pittsburgh-Des Moines Steel Co.
Plastics & Coal Chemicals Division of Allied Chemical
Portable Bridge & Equipment Co.
Pottermeter Co., Division of Potter Aeronautical Corp.
Protecto Wrap Co.

Quality March Equipment Co., Inc.

R-P & C Valve Div., American Chain & Cable
Ramsey Winch Mfg. Co.
Ray-Test Engineers, Inc.
Reilly Tar & Chemical Corp.
Remco Manufacturing Co.
Ridgway Div., Elliott Co.
Rig Engineers & Fabricators Co., Inc.
Riggs, Wm. L. Co.
Robishaw Engineering Inc.
Rochester Manufacturing Co., Inc.
Rolo Manufacturing Co.
Ruberoid Co.

Shafer Valve Co.
Skinner, M. B. Co.
Sooner Boomer Mfg. Div.
Southern Mill & Mfg. Co.
Sprague Engineering Corp.
Standard Magnesium Corp.
Staytite Co.
Stearns, D. E. Co.
Stearns, N. C. Co.
Steel Forgings, Inc.
Stewarts & Lloyds Ltd.
Superior Equipment Co.
Sewco, Inc.

Textron, Inc., Homelite Division
Thermix Corp.
Thornhill-Craver Co., Inc.
Tinker & Rasor
Tretolite Co. Div. of Petrolite Corp.
Tube Turns Div. of Chemetron Corp.

Union Switch & Signal Div. of Westinghouse Air Brake Co.
U. S. Industries, Inc., Garrett Oil Tools, Inc. Division
United States Motors Corp.
United States Steel Corp., Oil Well Supply Division
Universal Oil Products Co.

Vereinigte Armaturen-Gessellschaft MBH
Vernon Tool Co., Ltd. Greenwood Valve Division
Voss, J. H. H. Co., Inc.

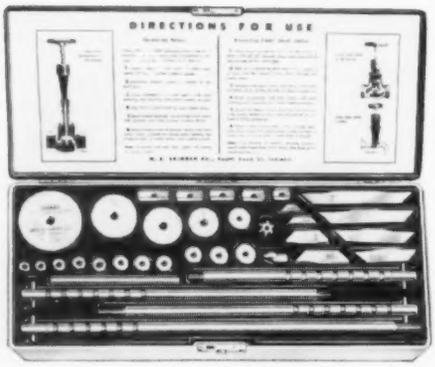
W-K-M Div. of ACF Industries, Inc.
Wachs, E. H. Co.
Waldron, John Corp.
Waukesha Motor Co.
Westinghouse Air Brake Co., Union Switch & Signal Division
White Diesel Engine Division The White Motor Co.
Whitmore Homebuilders, Inc.
Wickwire Spencer Steel Division The Colorado Fuel & Iron Corp.
Wilkinson Products Co.
Williamson, T. D. Inc.
Worthington Corp.
Worthington Corp., Mason-Neilan Division

Yale Machine Works

Zeligson Truck & Equipment Co.

PIPE LINE CATALOG

RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50

FREE catalog showing our pipe repair clamps, saddles, and reseating tools

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers' Index. Simply circle code numbers of items desired—sign and mail card.

Air Compressors

Ingersoll-Rand Company has published a new booklet "Compressed Air Fundamentals" to aid in the selection of a small packaged air compressor.

The booklet describes compressed air, how it is compressed, single-and-two stage compressors, piston displacement, actual delivery, unloading of compressors, regulation and types of control used.

To get a copy, circle **No. E13** on Readers' Service Card, last page this issue.

Brush Cutter

Servis Equipment Company offers illustrated bulletins on its Gyro 84 brush cutter which is used for right of way maintenance.

With extra heavy blades and blade carrier, the brush cutters can do heavy cutting with minimum power.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

Gas Drive

Rockwell Manufacturing Company has issued a four-page bulletin on its completely self-contained air or gas-powered instrument drive and timing unit.

The "gas drive" is particularly applicable for offshore gas gathering systems, remote location installations and where it is not always possible to manually wind a standard chart drive.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Crawler Tractor

Allis-Chalmers Manufacturing Company has released a bulletin on its HD-6 diesel powered crawler tractor. Photographs, charts, graphs and other illustrations bring complete information about the unit.

Many accessories designed and engineered for the tractor and which increase its versatility are also pictured in the new catalog. Specifications also are included.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Plastic Pipe

Southwestern Plastic Pipe Company announces a six-page brochure on its plastic pipe. For use on crude flow lines, gas gathering systems and transmission systems, the company produces polyethylene, polyvinyl chloride and acrylonitrile butadiene styrene copolymer plastic pipe.

A description of each of the types of pipe is contained in the bulletin.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Construction Activity

A reprinting of "Products for the Construction Industry" has been announced by Le Roi Division, Westinghouse Air Brake Company. New illustration and information on the Le Roi rotary and piston type portable air compressors is included.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Protective Tapes

Permacel announces availability of a six-page bulletin describing its polyethylene and polyvinyl pipe line tapes. The bulletin also includes a section on Permacel's Primer used with the tapes.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Packaged Pipe Lines

Southern Pipe, Division of U.S. Industries, Inc., has issued a six-page, two-color bulletin on its lite-wall pipe. The illustrated bulletin includes a description on the processes involved in handling the lite-wall pipe.

The pipe is available in 5L Grade A or B and 5LX Grade X-42 and X-46.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Orifice Plate Sealing

A one-page specifications bulletin on orifice plate sealing units has been issued by Daniel Orifice Company.

The bulletin covers three types of Daniel-designed orifice units and the new plastic "teflon" seal, for sizes from 2 to 12-inches is described. Also included is the metallic seal available in all sizes and designed for high temperature application.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Adjustex Sheave

A two-page facts sheet has been issued by Allis-Chalmers Manufacturing Company on its Adjustex sheave. The new sheave provides positive torque transmission, interlocking lug design, easy adjustment, simplified dismantling and quick reassembly.

Offered in all pitch diameters and a new "C" section size, the 7.5/9.7 Adjustex sheaves are made in two, three and four grooves for use with A, B or C section belts.

To get acopy, circle **No. E22** on Readers' Service Card, last page this issue.

"On-the-line overhaul saves time, saves money"

W-K-M Leverlock® Gate Valves feature through-conduit gate construction, parallel expanding gates, exclusive gate centralizers, controlled force seating, pressure seal bonnets, super-finished stems, seating surfaces sealed from the lading flow.

Pressure Ratings: ASA 300 through ASA 1500 pounds.

W-K-M® ASA Gate Valves

These valves can be overhauled fast and easy. No other valves give you the same long-lasting service and economy. No other valves require so little maintenance, yet provide such outstanding efficiency and performance.

Next time — and every time — specify W-K-M! *Available at leading supply stores everywhere* (from 2″ through 12″). Sizes through 34″ available on special order.

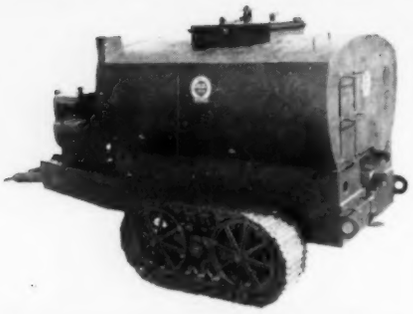
PRODUCT OF W-K-M's *Creative Engineering*

WRITE FOR CATALOG 300

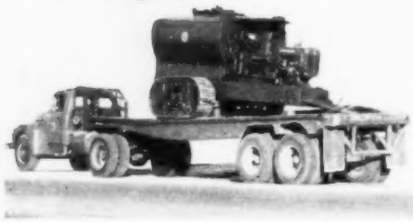
W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5913



HOT DOPE FROM MYOCO KETTLES



Dope stays hot and properly mixed when you use a MYOCO asphalt kettle. Completely insulated, it provides guaranteed heat retention, assuring almost no temperature differential of filler between top and bottom. Coking is unnecessary.

Settling is prevented through two-way agitation—a mechanically driven propeller and hydraulic bottom sweep.

Additional time, labor and money savings result from the MYOCO asphalt kettle's design, which eliminates the need for over-width highway transportation permit.

Safety is assured, since fuel tank is installed inside of frame and protected from firebox by bulkhead.

The MYOCO asphalt kettle is available in 10, 27, 30 barrel sizes, powered by a Wisconsin engine or its electric equivalent, and with Athey tracks, steel skids, or fitted for stationary use. Blower or mailbox type burners are optional.

Call or write:

MORRIS-YOUNG-OWENS CO. PIPELINE EQUIPMENT AND SUPPLIES MYOCO

MORRIS-YOUNG-OWENS CO.

PIPELINE EQUIPMENT AND SUPPLIES

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In Canada: MYOCO LIMITED, 30 Bloor St. West

Toronto 5, Ontario, Canada • Tel. WA 2-9444

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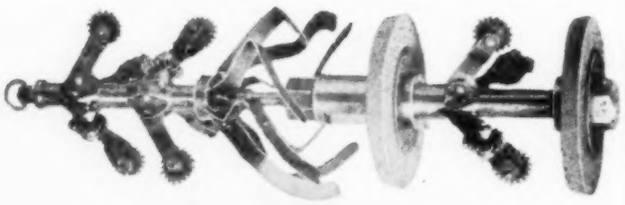
Go-Devil

NORTHRUP GO-DEVILS

Heavy Duty Model with Neoprene cup or disc drivers



G. A. COTTEN CO.

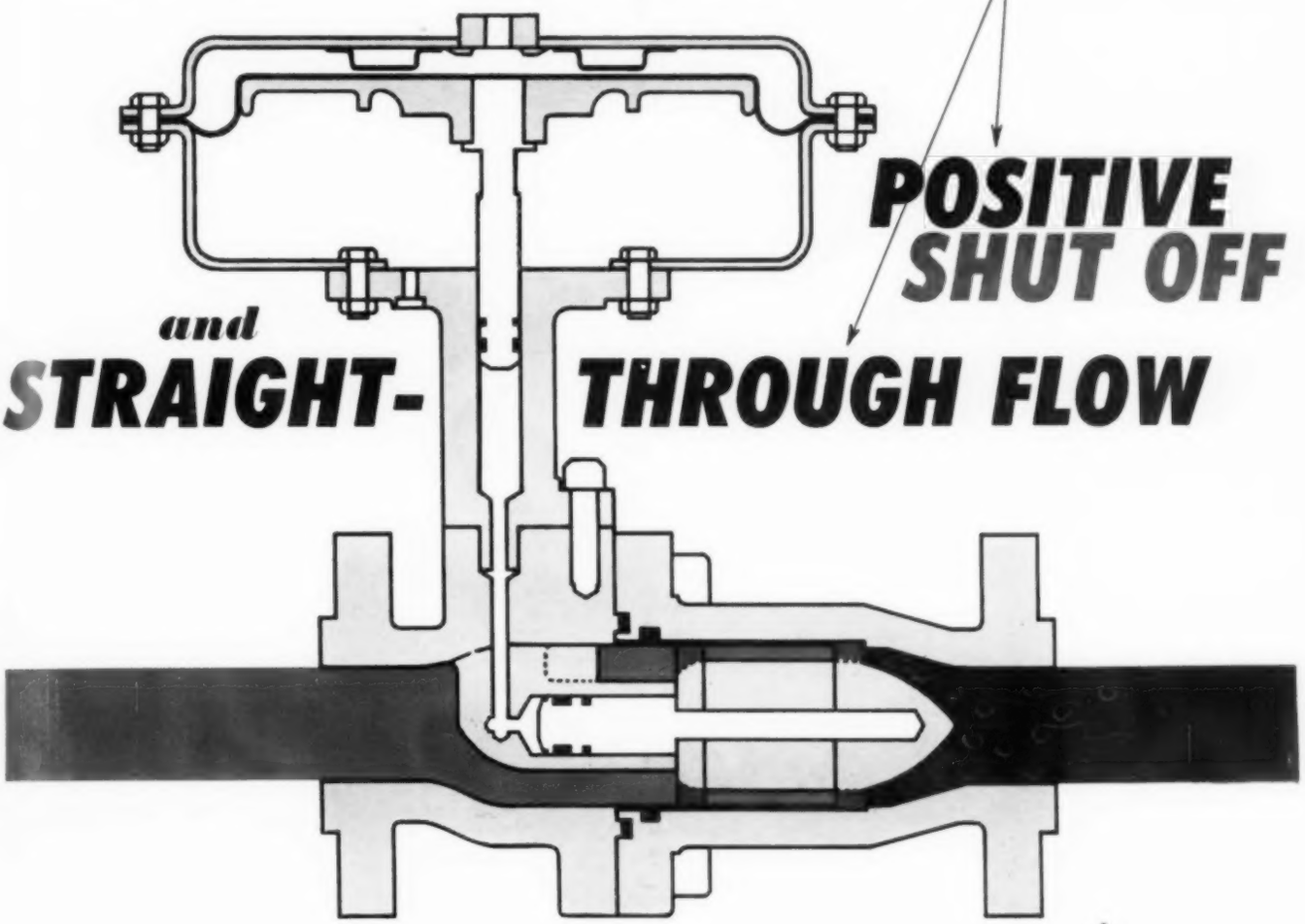
Manufacturers of **TRANSIT PIPE LINE SCRAPERS**

NORTHRUP GO-DEVILS &

P. O. Box 5332

Tulsa, Okla.

At last! A pressure reducing gas regulator with...



POSITIVE SHUT OFF

and

STRAIGHT-THROUGH FLOW

*

The NEW Jet Stream Regulator

Now you can stop high-speed gas turbulence, sound vibration, and leakage in your pressure regulators. The Jet Stream Regulator gives you straight-through laminar flow, positive shutoff, and no mechanical friction. Jet Stream's laminar flow stops the jetting of high speed gas and transient particles. This smooth straight-through flow also reduces sound vibration. Jet Stream's hydraulically actuated slave piston regulates flows with extremely fine control . . . from full flow to bubble-tight shutoff in three seconds. For efficiency and safety in your pressure reducing gas regulators . . . *use a Jet Stream Regulator!*

* *manufactured under the Welker Patent*

THE JET STREAM REGULATOR IS MADE IN THREE MODELS

• FLANGED • THREADED • INSERT

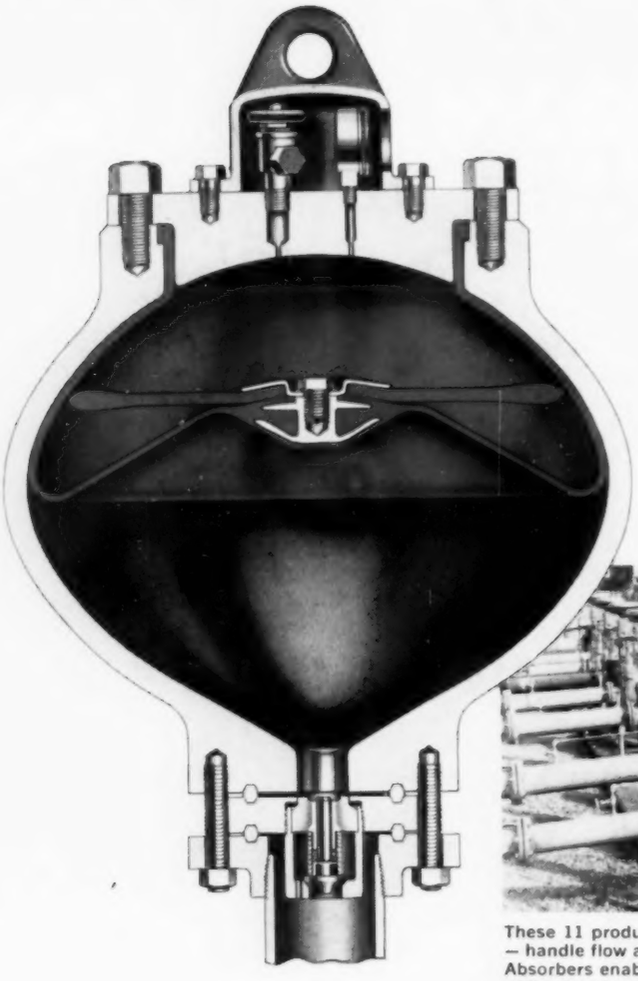
Write for the Jet Stream Catalog. A catalog giving complete specifications on the Jet Stream Regulator is available upon request.

APCO **DIVISION OF TEXTRON INC.**

engineering • design • development • manufacturing

616 WEST WHITTIER BOULEVARD • WHITTIER, CALIFORNIA • P.O. BOX 6965, HOUSTON, TEXAS

prolongs life of pipelines, fittings and pumps... saves downtime... cuts maintenance costs!



These 11 product transfer lines — some over 1,000 feet long — handle flow at the rate of 1,600 gpm each, yet Hydril Surge Absorbers enable them to be closed in a fraction of a second without over-pressuring lines, fittings or metering equipment.

HYDRIL TYPE "K" SURGE ABSORBER

smooths out shock and pulsation in pipelines

QUICK-CLOSING VALVES and piston-type pumps punish pipelines by imposing sudden peak pressure loads. Unless these surges can be absorbed or smoothed out, pipe and fittings are exposed to stresses which may cause costly failure.

Hydril Type "K" Surge Absorbers are successfully controlling many types of line surge and pulsation in petroleum product handling lines, water pumping systems and oilwell repressuring programs. Simple design and construction assures long, trouble-free operation. This same oil field-proven Hydril design has been used for many years as a pulsation dampener on high-pressure oilwell mud pumps. Servicing, though rarely required, is readily performed without special tools and without shutting down the system or removing the unit from the line. Available in a wide range of sizes and pressure ratings.

Another dependable Hydril pressure-control product

For more detailed information on Hydril Surge Absorbers, consult your Pipeline or Composite Catalog ... or call your Hydril Representative

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